DOCUMENT RESUME

ED 419 717 SE 061 849

AUTHOR	Takahira, Sayuri; Gonzales, Patrick; Frase, Mary; Salganik, Laura Hersh
TITLE	Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context. Initial Findings from the Third International Mathematics and Science Study.
INSTITUTION	National Center for Education Statistics (ED), Washington, DC.
REPORT NO	NCES-98-049
PUB DATE	1998-08-00
NOTE	145p.
AVAILABLE FROM	World-Wide Web: http://www.ed.gov/NCES/timss
PUB TYPE	Books (010) -- Reports - Research (143)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	*Academic Achievement; *Comparative Analysis; *Cross Cultural Studies; Educational Strategies; Elementary Secondary Education; Global Approach; *Grade 12; Mathematics Curriculum; *Mathematics Education; Science Curriculum; *Science Education
IDENTIFIERS	*Third International Mathematics and Science Study

ABSTRACT

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and rigorous international study of schools and student achievement ever conducted. This report compares the general mathematics and science knowledge of students in the United States in their last year of secondary school with that of students in 20 other countries, as well as the achievement of students taking physics and advanced mathematics courses with those in 15 other countries. Chapter 1 presents information about TIMSS. Chapter 2 draws from the results of all student assessments to describe how U.S. students performed in mathematics and science, whereas Chapter 3 focuses on the achievement of advanced students. Chapter 4 analyzes the context of learning in those countries included in the study. More detailed statistical data are presented in seven appendices. Contains 16 references. (ASK)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 419 717

SE 061 849

NATIONAL CENTER FOR EDUCATION STATISTICS

PURSUING EXCELLENCE

A STUDY OF U.S. TWELFTH-GRADE MATHEMATICS AND SCIENCE ACHIEVEMENT IN INTERNATIONAL CONTEXT

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

INITIAL FINDINGS FROM THE
THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT
U.S. DEPARTMENT OF EDUCATION

NCES 98-049

BEST COPY AVAILABLE

Pursuing Excellence

A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context

Sayuri Takahira
Patrick Gonzales
Mary Frase
Laura Hersh Salganik

United States National Coordinating Committee:

Eugene Owen
Lois Peak
William Schmidt
Larry Suter

Contributors:

Nancy Caldwell
Leland Cogan
Margaret Cozzens
Leslie Jocelyn
David Kastberg
John Konstant
David Nohara
Molly Soule
Brian Thompson
Gilbert Valverde
Pamela Warner
Christine Welch
Trevor Williams

Initial Findings from the
Third International Mathematics and Science Study

U.S. Department of Education
Richard W. Riley
Secretary

Office of Educational Research and Improvement
C. Kent McGuire
Assistant Secretary

National Center for Education Statistics
Pascal D. Forgione, Jr.
Commissioner

Data Development and Longitudinal Studies Group
Martin E. Orland
Associate Commissioner

International Activities Program
Eugene Owen
Director

National Center for Education Statistics

The National Center for Education Statistics (NCES) is the primary federal entity for collecting, analyzing, and reporting data related to education in the United States and other nations. It fulfills a congressional mandate to collect, collate, analyze, and report full and complete statistics on the condition of education in the United States; conduct and publish reports and specialized analyses of the meaning and significance of such statistics; assist state and local education agencies in improving their statistical systems; and review and report on education activities in foreign countries.

NCES activities are designed to address high priority education data needs; provide consistent, reliable, complete, and accurate indicators of education status and trends; and report timely, useful, and high-quality data to the U.S. Department of Education, the Congress, the states, other education policy makers, practitioners, data users, and the general public.

We strive to make our products available in a variety of formats and in language that is appropriate to a variety of audiences. You, as our customer, are the best judge of our success in communicating information effectively. If you have any comments or suggestions about this or any other NCES product or report, we would like to hear from you. Please direct your comments to:

National Center for Education Statistics
Office of Educational Research and Improvement
U.S. Department of Education
555 New Jersey Avenue NW
Washington, DC 20208-5574
Phone: (202) 219-1333
e-mail: timss@ed.gov

Suggested Citation:
U.S. Department of Education. National Center for Education Statistics.
Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context,
NCES 98-049. Washington, DC: U.S. Government Printing Office, 1998.

February 1998
REVISED August 1998

Available for downloading at http://nces.ed.gov/timss

NATIONAL CENTER FOR EDUCATION STATISTICS

ERRATA

Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context

1. p. 74. The last sentence should read, "Twelve percent of U.S. advanced mathematics students stated that they received five or more hours of mathematics instruction per week, compared to an international average of **37** percent."

   Also, p. 136, Appendix 5, Table A5.21. The international average of the percentage of students participating in the advanced mathematics assessment who receive five or more hours of mathematics instruction per week should be **37** percent.

2. p. 99, Appendix 2, Table A2.2. The average score in physics for the Russian Federation should be **545**, with a standard error of **11.6**. The average score for the Russian Federation in advanced mathematics should be **542**, with a standard error of **9.2**.

3. p. 117, Appendix 5, Table A5.6. The difference in the average scores between males and females in the Netherlands should be **49**.

4. p. 129, Appendix 5, Table A5.17. The difference in the average age of Austrian students should be **4.8** years. The average difference in average age of participants in the two assessments for nations with the same standing relative to the international average in eighth grade compared to the final year of secondary school should be **4.5** years.

5. p. 131, Appendix 5, Table A5.19. For Cyprus, the average age for eighth-grade students should be **13.7** years, and for final year of secondary school students the average age should be **17.7** years. The difference in average age of participants in the two assessments for students in the Netherlands should be **4.2** years.

October 8, 1998

U.S. Department of Education
Office of Educational Research and Improvement **NCES 98-049e**

ACKNOWLEDGMENTS

The authors wish to thank all those who contributed to the production of this report through their insightful suggestions. The invited reviewers who gave of their time and expertise included: Susan Fuhrman of the University of Pennsylvania; Henry Heikkinen of the University of Northern Colorado; Mary Lindquist of Columbus State University; Laura Lippman of NCES; and Robert Burton of NCES. We would also like to thank the many other individuals both within and outside the Department of Education who provided helpful comments during the development of this report.

COMMISSIONER'S STATEMENT

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study of schools and student achievement ever conducted. This report, *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*, compares the general mathematics and science knowledge of our students in their last year of secondary school with those of 20 other countries, as well as the achievement of our students taking physics and advanced mathematics courses with those in 15 other countries. It is the last of three major TIMSS reports by the National Center for Education Statistics (NCES) in its *Pursuing Excellence* series. The first report, outlining U.S. comparative eighth-grade results, was released in November 1996, and the second report, detailing fourth-grade results, was released in June 1997. Together, these three studies paint the most complete picture ever of how achievement in mathematics and science by U.S. students compares with that of other nations. The information is intended to help U.S. educators, parents, policymakers, and others evaluate the strengths and weaknesses of our schools from an international perspective. This comparative portrait can be used to examine our education system, scrutinize improvement plans, and evaluate proposed standards and curricula.

The scope of TIMSS is unprecedented in the annals of education research. The international project involved the testing of more than one-half million students in mathematics and science at three grade levels in 41 countries. In contrast to previous international comparative studies, TIMSS also goes beyond the traditional "horserace" data on student performance to explore possible causes for differences in achievement including questions on students' lives inside and outside of the classroom.

This wealth of data is being analyzed and published by NCES and others around the world. TIMSS has become the most accessible international education study ever by releasing information in a variety of new forms, including CD-ROM, videotape, and the World Wide Web (http://nces.ed.gov/timss). We invite everyone who is dedicated to enhancing the quality of our nation's mathematics and science education to make the fullest possible use of this rich resource.

Together, the various TIMSS reports constitute important tools that can improve the quality of primary and secondary education for all students. That is why the Center has worked cooperatively with other parts of the U.S. Department of Education to produce a multi-media resource kit designed for educators and those interested in using TIMSS data to improve teaching, curricula, and student achievement in states and local communities. We also will be conducting a follow-up study in 1999, when the students who took TIMSS in the fourth grade have reached the eighth grade, both to compare their performance with the 1995 eighth-grade results, and to assess the level of progress made by this group of students over the intervening four years.

The TIMSS data provide a reference point from which we can begin to clarify what we mean by "world-class" education. They give us tools by which we can benchmark not only the performance of our students but also the way in which we deliver instruction. Most importantly, they allow the U.S. to learn unique lessons from other members of the world community so that we may better pursue the goal of an excellent education for all students.

Pascal D. Forgione, Jr.

Pascal D. Forgione, Jr.
Commissioner of Education Statistics

February 1998

NSF DIRECTOR'S STATEMENT

The Third International Mathematics and Science Study (TIMSS) was designed explicitly to enable educators and policy makers to compare achievement in science and mathematics of students in the United States with those in other countries at three levels of education, grades 4, 8, and the final year of secondary school (grade 12 in the U.S.). With this publication of the results of the 1995 assessment of the final year of secondary school, TIMSS has been successful. In addition, differences in student learning and characteristics of schooling, as measured by the TIMSS assessment instruments and questionnaires, enhance our understanding of the possible influences of such factors as school organization, teaching practices, student study habits, and family background. But the secrets of raising the level of student achievement beyond their current levels are not readily uncovered, and this study provides no easy answers or quick fixes.

The results of students in the final year of secondary school in the TIMSS science and mathematics general knowledge assessments found that our students performed less well than they did at grade 8, significantly below the international mean. In addition, U.S. most advanced students (those taking pre-calculus or calculus and those taking physics) performed at low levels in advanced mathematics and at especially low levels in physics when compared with similar students in other countries.

Once the results for all grades are considered, we see that U.S. students in the early school years have reasonable levels of achievement when compared with other countries—in science they are actually rated near the top—but performance lags by grade 8 and becomes even poorer at grade 12. The report's new information about advanced students should be reviewed carefully by college and university policy makers as well as those who influence coursetaking and career decisions made during the high school years.

Results of the advanced mathematics test reveal some unexpected weaknesses. Despite the fact that about one-quarter of the test related to calculus and that one-half of the U.S. advanced mathematics students were actually studying calculus, it was in geometry, not calculus, where U.S. students performed worst. This is consistent with performance in grades 4 and 8, but unexpected because these advanced students have all had formal geometry coursework. The results show that both geometry and algebra need to be key subjects of study throughout the curriculum.

For me, as a physicist with a keen interest in education, the science results are even more troubling. Students performed poorly in most sub-areas of physics, with the poorest performance coming on items on mechanics and electricity/magnetism (areas that account for about 75 percent of American physics textbooks). Even students who took an Advanced Placement physics course scored below the international norm.

These studies suggest that students appear to disengage from learning critical mathematics and science content as they progress through the school system. The sources of disengagement may include the classroom environment, the quality of

instruction, and parental and community support for the value of science and mathematics to our children's future.

Improving achievement in mathematics and science subjects, whether in basic skills or advanced critical thinking, will require that students have, in combination, access to good teachers, good teaching materials, and agreement within the school on the goals of learning for all students. There are many efforts underway in states and localities throughout the United States to reform the process of teaching and learning mathematics and science. They are beginning to reveal mechanisms for obtaining gains in achievement. TIMSS also provides us with examples of nations with high performance at all grade levels, most notably Canada, the Netherlands, and Switzerland. American educators need to examine these successful efforts, learn from them, and effectively use all available resources to improve teaching and learning in mathematics and science at all grade levels.

Neal Lane

Neal Lane, Director
National Science Foundation

February 1998

TABLE OF CONTENTS

ACKNOWLEDGMENTS 3
COMMISSIONER'S STATEMENT 5
NSF DIRECTOR'S STATEMENT 7
LIST OF FIGURES 13
EXECUTIVE SUMMARY 17

CHAPTER 1: INTRODUCTION 20
What Is TIMSS? 21
Comparing the United States to Other Countries 24
The TIMSS Research Team 25
What Questions Does This Report Answer? 25

CHAPTER 2: ACHIEVEMENT OF ALL STUDENTS 28
Key Points 28
Mathematics and Science General Knowledge 29
Mathematics General Knowledge Assessment 30
How well do U.S. twelfth graders do on the mathematics general knowledge assessment? 30
What were students asked to do on the mathematics general knowledge assessment? 31
How does U.S. twelfth-grade students' relative performance in mathematics compare to that of U.S. eighth-grade students? 33
Is there a gender gap in mathematics general knowledge at the twelfth grade? 34
Has the relative international standing of the United States in mathematics at the end of secondary school changed over time? 34
Science General Knowledge Assessment 35
How well do U.S. twelfth graders do on the science general knowledge assessment? 35
What were students asked to do on the science general knowledge assessment? 35
How does U.S. twelfth-grade students' relative performance in science compare to that of U.S. eighth-grade students? 37
Is there a gender gap in science general knowledge at the twelfth grade? 38
Has the relative international standing of the United States in science at the end of secondary school changed over time? 39
How does the performance of U.S. twelfth graders in science compare to their performance in mathematics? 39

CHAPTER 3: ACHIEVEMENT OF ADVANCED STUDENTS 40
Key Points 40
Advanced Mathematics Assessment 41
How do U.S. twelfth graders with advanced mathematics instruction compare to advanced mathematics students in other countries? 42

How do U.S. twelfth graders with calculus or Advanced Placement calculus compare to all advanced mathematics students in other countries? . . . 43
How do U.S. students score in the different content areas of advanced mathematics? . . . 44
What were students asked to do on the advanced mathematics assessment? . . . 47
Is there a gender gap in advanced mathematics at the twelfth grade? . . . 50
Physics Assessment . . . 50
How do U.S. twelfth graders with physics instruction compare to advanced science students in other countries? . . . 50
How do U.S. twelfth graders with Advanced Placement physics instruction compare to advanced science students in other countries? . . . 52
How do U.S. students score in the different content areas of physics? . . . 53
What were advanced science students asked to do on the physics assessment? . . . 53
Is there a gender gap in physics at the twelfth grade? . . . 57
How does U.S. student performance in physics compare to that in advanced mathematics? . . . 57

CHAPTER 4: THE CONTEXT OF LEARNING . . . 58
Key Points . . . 58
The Context of Learning for Students Participating in the General Knowledge Assessments . . . 60
How does secondary schooling in the other TIMSS countries resemble and differ from that in the United States? . . . 60
How do U.S. twelfth-grade students compare internationally on factors associated with their lives inside and outside of school? . . . 64
Which of these factors related to education systems and students are associated with the relatively poor performance of U.S. twelfth graders in TIMSS on the general knowledge assessments? . . . 67
Why do U.S. students perform more poorly relative to the international average at the end of secondary schooling than in eighth grade? . . . 71
The Context of Learning for Advanced Mathematics and Science Students in the Final Year of Secondary School . . . 73
How do U.S. physics and advanced mathematics students compare internationally on factors associated with their lives in school? . . . 74
Are any of these instructional experiences of physics and advanced mathematics students associated with U.S. relative performance? . . . 76
Discussion . . . 78

CONCLUSIONS . . . 80

WORKS CITED . . . 82

APPENDIX 1: Summary Of International Study Guidelines And Definition Of Eligible Students 85
A1.1: Nations' Definitions Of Eligible Students And Whether Met Sampling Standards: Mathematics And Science General Knowledge Assessments 86
A1.2: Nations' Definitions Of Eligible Students And Whether Met Sampling Standards: Advanced Mathematics Assessment 90
A1.3: Nations' Definitions Of Eligible Students And Whether Met Sampling Standards: Physics Assessment 93

APPENDIX 2: National Average Scores, Percentiles Of Achievement, And Standard Errors 97
A2.1: National Average Scores And Standard Errors: Mathematics And Science General Knowledge 98
A2.2: National Average Scores And Standard Errors: Physics And Advanced Mathematics 99
A2.3: Percentiles Of Achievement In Mathematics General Knowledge: Final Year Of Secondary School 100
A2.4: Percentiles Of Achievement In Science General Knowledge: Final Year Of Secondary School 101
A2.5: Percentiles Of Achievement In Advanced Mathematics: Final Year Of Secondary School 102
A2.6: Percentiles Of Achievement In Physics: Final Year Of Secondary School 103

APPENDIX 3: Performance on Assessment Item Examples By Country 105
A3.1: Performance On Assessment Items Examples By Country: Mathematics And Science General Knowledge 106
A3.2: Performance On Assessment Items Examples By Country: Physics And Advanced Mathematics 107

APPENDIX 4: Scores and Standard Errors for U.S. AP and Non-AP Physics and Calculus Students 109
A4.1: U.S. AP and Non-AP Calculus Students' Scores By Content Area 110
A4.2: U.S. AP and Non-AP Physics Students' Scores By Content Area 110

APPENDIX 5: Additional Supporting Materials 111
A5.1: Mathematics Performance At Eighth Grade And Final Year Of Secondary School For The 20 Countries That Participated In TIMSS At Both Grade Levels 112
A5.2: Mathematics Performance At Fourth Grade And Final Year Of Secondary School For The 12 Countries That Participated In TIMSS At Both Grade Levels 113
A5.3: Achievement In Mathematics General Knowledge By Gender For Students In Their Final Year Of Secondary School 114

A5.4: Science Performance At Eighth Grade And Final Year Of Secondary School For The 20 Countries That Participated In TIMSS At Both Grade Levels 115

A5.5: Science Performance At Fourth Grade And Final Year Of Secondary School For The 12 Countries That Participated In TIMSS At Both Grade Levels 116

A5.6: Achievement In Science General Knowledge By Gender For Students In Their Final Year Of Secondary School 117

A5.7: Advanced Mathematics And Advanced Science Students As A Proportion Of Age Cohort And Performance On Advanced Mathematics And On Physics Assessments Relative To The United States 118

A5.8 Gender Differences In Advanced Mathematics Achievement For Students In Their Final Year Of Secondary School Having Taken Advanced Mathematics 119

A5.9: Achievement In Advanced Mathematics Content Areas By Gender For Students Having Taken Advanced Mathematics 120

A5.10: Gender Differences In Physics Achievement For Students In Their Final Year Of Secondary School Having Taken Advanced Science 121

A5.11: Achievement In Physics Content Areas By Gender For Advanced Science Students 122

A5.12: Extent Of Differentiation In Secondary Education And Performance On TIMSS General Knowledge Assessments Relative To The United States 124

A5.13: Average Age Of Students Assessed And Grades Included In General Knowledge Assessments Compared To Performance On Mathematics General Knowledge Assessment Relative The United States 125

A5.14: Secondary Enrollment And Completion Compared To The United States 126

A5.15: Centralization Of Decision-Making About Curriculum Syllabi And Performance On Mathematics And Science General Knowledge Assessments Relative To The United States 127

A5.16: Gross National Product Per Capita And Public Expenditure On Elementary And Secondary Education Of TIMSS Nations Compared To Performance On The Mathematics General Knowledge Assessment Relative To The United States 128

A5.17: Average Age Of Participants In TIMSS Eighth-Grade Mathematics Assessment And Final Year Of Secondary School Mathematics General Knowledge Assessment And Nations' Relative Standing In Achievement In The Two Assessments 129

A5.18: Mathematics And Science Coursetaking And Change In Standing Relative To The International Average Between Eighth Grade And Final Year Of Secondary School 130

A5.19: Average Age Of Participants In TIMSS Eighth-Grade Science Assessment And Final Year Of Secondary School Science General Knowledge Assessment And Change In Nations' Standing Relative To The International Average From Eighth Grade To Final Year Of Secondary School 131

A5.20: Responses To Selected Student Questionnaire Items: Responses Of Students Participating In Mathematics And Science General Knowledge Assessments 132

A5.21: Responses To Selected Student Questionnaire Items: Responses of Students Participating In Advanced Mathematics Assessment 136

A5.22: Responses To Selected Student Questionnaire Items: Responses Of Students Participating In Physics Assessment 138

APPENDIX 6: Advisors To The U.S. TIMSS Study 141

APPENDIX 7: Additional TIMSS Reports 143

LIST OF FIGURES

FIGURE 1: Mathematics General Knowledge Achievement 30

FIGURE 2: Example 1: Mathematics General Knowledge Item 32

FIGURE 3: Example 2: Mathematics General Knowledge Item 32

FIGURE 4: Example 3: Mathematics General Knowledge Item 33

FIGURE 5: Science General Knowledge Achievement 36

FIGURE 6: Example 4: Science General Knowledge Item 36

FIGURE 7: Example 5: Science General Knowledge Item 37

FIGURE 8: Example 6: Science General Knowledge Item 38

FIGURE 9: Average Advanced Mathematics Performance Of Advanced Mathematics Students In All Countries 43

FIGURE 10: Average Advanced Mathematics Performance Of Advanced Mathematics Students In Other Countries Compared With U.S. Calculus And AP Calculus Students 44

FIGURE 11: Average Advanced Mathematics Performance Of Advanced Mathematics Students In Other Countries Compared With U.S. AP Calculus Students 45

FIGURE 12: Achievement In Advanced Mathematics Content Areas 46

FIGURE 13: Example 7: Geometry Item 47

FIGURE 14: Example 8: Probability And Statistics Item 48

FIGURE 15: Example 9: Calculus Item 49

FIGURE 16: Average Physics Performance Of Advanced Science Students In All Countries 51

FIGURE 17: Average Physics Performance Of Advanced Science Students In Other Countries Compared with U.S. AP Physics Students 52

FIGURE 18: Achievement In Physics Content Areas 54

FIGURE 19: Example 10: Mechanics Item 56

FIGURE 20: Example 11: Heat Item 56

FIGURE 21: Example 12: Wave Phenomena Item 57

FIGURE 22: Age Beginning Grade 1 And Grade(s) Marking End Of Secondary School in TIMSS Nations 62

FIGURE 23: U.S. Twelfth-Grade Students' Reports on Personal Safety at School In Comparison With The International Average 67

FIGURE 24: U.S. Twelfth-Grade Students' Reports On Hours On A Normal School Day Spent Working At A Paid Job In Comparison With The International Average 68

FIGURE 25: Relationship Between U.S. Relative Performance And Schooling And Student Factors: Mathematics General Knowledge 69

FIGURE 26: Relationship Between U.S. Relative Performance And Schooling And Student Factors: Science Knowledge Assessments 70

FIGURE 27: Relationship Between U.S. Relative Performance And Education System Factors: Grade Eight And End Of Secondary School 72

FIGURE 28: Advanced Mathematics Students' Reports On Connecting Mathematics To Everyday Problems 76

FIGURE 29: Relationship Between U.S. Relative Performance And Instructional Factors: Physics And Advanced Mathematics Students 77

EXECUTIVE SUMMARY

INTRODUCTION

- The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international comparison of education ever undertaken. During 1995, the study assessed the mathematics and science knowledge of a half-million students from 41 nations at three levels of schooling.

- The information in this report is about students who were assessed at the end of twelfth grade in the United States and at the end of secondary education in other countries. It includes four areas of performance: mathematics general knowledge, science general knowledge, physics, and advanced mathematics.

- This report on students in the final year of secondary school is the last in a series of three public-audience reports titled *Pursuing Excellence*. The first report presented findings on student achievement at eighth grade. The second report presented findings from the fourth grade.

- TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. The students who participated in TIMSS were scientifically selected to accurately represent students in their respective nations. The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities arose, including the United States, are clearly noted in this and other TIMSS reports.

- Criticisms of previous international studies comparing students near the end of secondary school are not valid for TIMSS. Because the high enrollment rates for secondary education in the United States are typical of other TIMSS countries, our general population is not being compared to more select groups in other countries. Further, the strict quality controls ensured that the sample of students taking the general knowledge assessments was representative of all students at the end of secondary school, not just those in academically-oriented programs.

- This report consists of three parts: initial findings from the assessments of mathematics and of science general knowledge; initial findings from assessments of physics and of advanced mathematics; and initial findings about school systems and students' lives; and how those are associated with the relative performance of U.S. students compared to those in other cultures.

ACHIEVEMENT OF ALL STUDENTS

- A sample of all students at the end of secondary school (twelfth grade in the United States) was assessed in mathematics and science general knowledge. Mathematics general knowledge and science general knowledge are defined as the knowledge of mathematics and of science needed to function effectively in society as adults.

- U.S. twelfth graders performed below the international average and among the lowest of the 21 TIMSS countries on the assessment of

mathematics general knowledge. U.S. students were outperformed by those in 14 countries, and outperformed those in 2 countries. Among the 21 TIMSS nations, our students' scores were not significantly different from those in 4 countries.

- U.S. twelfth graders also performed below the international average and among the lowest scoring of the 21 TIMSS countries on the assessment of science general knowledge. U.S. students were outperformed by students in 11 countries. U.S. students outperformed students in 2 countries. Our students' scores were not significantly different from those of 7 countries, including France, Germany, Italy, and the Russian Federation.

- The international standing of U.S. students was stronger at the eighth grade than at the twelfth grade in both mathematics and science among the countries that participated in the assessments at both grade levels.

- The U.S. international standing on the general knowledge component of TIMSS was higher in science than in mathematics. This pattern is similar to the findings at fourth and eighth grades in TIMSS.

- The U.S. was one of three countries that did not have a significant gender gap in mathematics general knowledge among students at the end of secondary schooling. While there was a gender gap in science general knowledge in the United States, as in every other TIMSS nation except one, the U.S. gender gap was one of the smallest.

ACHIEVEMENT OF ADVANCED STUDENTS

- The advanced mathematics assessment was administered to students who had taken or were taking pre-calculus, calculus, or AP calculus in the United States and to advanced mathematics students in other countries. The physics assessment was administered to students in the United States who had taken or were taking physics or AP physics and to advanced science students in other countries.

- Performance of U.S. physics and advanced mathematics students was among the lowest of the 16 countries which administered the physics and advanced mathematics assessments. In physics, 14 countries outperformed the United States; no countries performed more poorly. In advanced mathematics, 11 countries outperformed the United States and no countries performed more poorly.

- In all five content areas of physics and in all three content areas of advanced mathematics, U.S. physics and advanced mathematics students' performance was among the lowest of the TIMSS nations.

- In both physics and advanced mathematics, males outperformed females in the United States and most of the other TIMSS countries.

- More countries outperformed the United States in physics than in advanced mathematics. This differs from the results for mathematics and science general knowledge, as well as the results at grades 4 and 8, where more countries outperformed the United States in mathematics than in science.

CONTEXTS OF LEARNING

- It is too early in the process of data analysis to provide strong evidence to suggest factors that may be related to the patterns of performance at the end of secondary schooling described here.

- Although secondary education in the United States differs structurally in important dimensions from that in many of the other countries, in this first analysis, few of those structural differences are clearly related to the relatively poor performance of our twelfth graders on the TIMSS assessments.

- Although the lives of U.S. graduating students differ from those of their peers in other countries on several of the factors examined, few appear to be systematically related to our performance in twelfth grade compared to the other countries participating in TIMSS.

- Further analyses are needed to provide more definitive insights on these subjects.

CONCLUSIONS

- U.S. students' performance was among the lowest of the participating countries in mathematics and science general knowledge, physics, and advanced mathematics.

- TIMSS does not suggest any single factor or combination of factors that can explain why our performance at twelfth grade is low relative to other countries at the end of secondary education.

- From our initial analyses, it also appears that some factors commonly thought to be related to individual student performance are not strongly related to national averages of student performance at the end of secondary school in TIMSS.

- TIMSS provides a rich source of information about student performance in mathematics and science, and about education in other countries. These initial findings suggest that to use the study most effectively, we need to pursue the data beyond this initial report, taking the opportunity and time to look at interrelationships among factors in greater depth.

CHAPTER 1:
INTRODUCTION

The Third International Mathematics and Science Study (TIMSS) is the largest and most comprehensive comparative international study of education that has ever been undertaken. TIMSS in the United States was coordinated by the National Center for Education Statistics (NCES) and the National Science Foundation (NSF). The study assessed a half-million students from 41 countries in 30 languages to compare their mathematics and science achievement. This report focuses on the 23 countries that participated in the TIMSS study of students at the end of secondary education.

TIMSS comes at a time when mathematics and science achievement has been designated as an educational priority. One of our eight current National Education Goals is that "by the year 2000, the United States will be first in the world in mathematics and science achievement." In addition, mathematics and science experts have issued major calls for reform in the teaching of their subjects. The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics*[1] in 1989, and *Professional Standards for Teaching Mathematics*[2] in 1991. In 1993, the American Association for the Advancement of Science followed suit with *Benchmarks for Science Literacy*,[3] and in 1996, the National Academy of Sciences published *National Science Education Standards*.[4]

This is the last of three reports in the *Pursuing Excellence* series. The first report presented initial findings on the eighth grade and was released in November, 1996. The second report presented findings on the fourth grade and was released in June, 1997. This report presents initial findings about the international standing of the United States' twelfth graders relative to students completing secondary school in other countries. It is based on the comparative data published in the report, *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study*.[5] The TIMSS International Study Center at Boston College will release complete data files for the study later this year, which will allow a more extensive examination of student performance in mathematics and science in the participating countries.

WHAT IS TIMSS?

TIMSS is the third comparison of mathematics achievement and third comparison of science achievement carried out by the International Association for the Evaluation of Educational Achievement (IEA). Previous IEA studies of mathematics and science were conducted for each subject separately at various times during the 1960s, 1970s, and 1980s. TIMSS is the first IEA study that has assessed both mathematics and science at the same time. Comparative studies of other subjects, including reading literacy (1992)[6] and computers in education (1993),[7] have also been published by the IEA.

TIMSS was designed to focus on students at three different stages of schooling: midway through elementary school, midway through lower secondary school, and at the end of upper secondary school. Initial findings for the 41 countries in the lower secondary school component[8] and for the 26 countries that participated in the elementary school component[9] are reported in earlier volumes of the *Pursuing Excellence* series. This report presents initial findings for the 23 countries

in the remaining component of TIMSS, students at the end of secondary education. Findings are presented for four broad areas of performance:

- Mathematics general knowledge[5] for all students in the final year of secondary education, including those who had taken advanced courses as well as those who had not;
- Science general knowledge[5] for all students in the final year of secondary education, including those who had taken advanced science courses as well as those who had not;
- Advanced mathematics for students in the final year of secondary education who had taken or were taking advanced courses in mathematics; and
- Physics for students in the final year of secondary education who had taken or were taking physics.

For the assessments of mathematics general knowledge and science general knowledge, this report presents results for 21 countries: Australia, Austria, Canada, Cyprus, the Czech Republic, Denmark, France, Germany, Hungary, Iceland, Italy, Lithuania, the Netherlands, New Zealand, Norway, the Russian Federation, Slovenia, South Africa, Sweden, Switzerland, and the United States.

For the assessment of advanced mathematics, results are reported for 16 countries: Australia, Austria, Canada, Cyprus, the Czech Republic, Denmark, France, Germany, Greece, Italy, Lithuania, the Russian Federation, Slovenia, Sweden, Switzerland, and the United States.

For the physics assessment, results are reported for 16 countries: Australia, Austria, Canada, Cyprus, the Czech Republic, Denmark, France, Germany, Greece, Latvia, Norway, the Russian Federation, Slovenia, Sweden, Switzerland, and the United States.

The elementary and middle school components of TIMSS defined eligible students primarily on the basis of age. The elementary school group included students enrolled in the pair of adjacent grades that contained the most 9-year-olds, grades 3 and 4 in the United States and most other countries. The middle school students were in the pair of grades that contained the most 13-year-olds, grades 7 and 8 in the United States and most other countries.

A major goal of the end of secondary school component of TIMSS was to measure what students know by the time they leave the secondary school system. Because countries have different structures for secondary education, the final grade of secondary education in the countries participating in TIMSS may be as low as 9 and as high as 14, depending on the country and program in which the student is enrolled. For the United States, the final year of secondary education is grade 12, and twelfth-grade students were selected for the study. All twelfth graders were eligible for the

[5] The terms "mathematics general knowledge" and "science general knowledge" used throughout this report are equivalent to the terms "mathematics literacy" and "science literacy" used in the international report on achievement in the final year of secondary school published by Boston College.

mathematics and science general knowledge portion of the study. Advanced mathematics students in the United States were defined as twelfth graders who had taken or were taking a full year of a high school course that included the word "calculus" in the title, including pre-calculus. Physics students were twelfth graders who had taken or were taking at least one full year of high school physics. Appendix 1 provides information about how other countries identified students to participate in the study.

Students in both public and private schools were administered the mathematics and science general knowledge assessments, which together were about 1.5 hours in length, and included both multiple-choice and free-response items. In each country, the items were translated into the primary languages of instruction. In the United States, all assessments were administered in English. Testing occurred 2 to 3 months before the end of the 1994-95 school year. Students with special needs and disabilities that would make it difficult for them to take the assessments were excused. Students were allowed to use calculators for all assessments.

Like the other components of TIMSS, participating countries collected data beyond the student assessments. Students completed questionnaires about their experiences in and out of school. School administrators completed questionnaires about school policies and practices. An exploratory curriculum analysis compared mathematics and science curriculum guides and textbooks. It studied subject-matter content, sequencing of topics, and expectations for student performance. Teacher questionnaires were not administered, as some of the graduating students who participated in the study were no longer enrolled in mathematics and science.

TIMSS is the most fair and accurate international comparison of students that has ever been undertaken. In each nation, the students who participated in TIMSS were to be randomly selected to represent all students meeting the grade level or age criteria for each of the three populations. An international curriculum analysis was carried out prior to the development of the assessments to ensure that the items would reflect the mathematics and science curricula in the TIMSS countries. To further ensure that the assessments measured knowledge that the world community considers important for students to know, the items were developed by international committees. International monitors carefully checked the translations and visited many classrooms while the assessments were being administered in each of the participating countries to make sure that the instructions were properly followed.

The quality standards for the sampling process in TIMSS were higher than in any previous international comparison of education systems. Maintaining these high standards provided challenges for most of the countries that participated in this portion of TIMSS. Most of the 23 countries—including the United States—experienced difficulties of various types. This is consistent with experience in the United States in conducting assessments at the end of high school. Areas of difficulty included minimizing the extent to which students were excluded from the population eligible for the sample and gaining participation of schools and students after they were selected for the sample.

While most countries had difficulties meeting the sampling standards in this portion of TIMSS, the nature of these difficulties, and the students and schools excluded, are generally well understood. Appendix 1 contains a summary of the TIMSS study guidelines and provides information about sampling and adherence to sampling and other standards in all the countries. All countries in which difficulties arose are shown in parentheses in the figures and tables in this report. The United States is in parentheses because its combined school and student participation rate was 64 percent, below the standard of 75 percent. It is most likely that as a group, schools and students who were selected for TIMSS but did not participate in the assessments in the United States would have had below average scores, thus lowering the U.S. average. This was probably the case as well in other countries having similar difficulties.

Full documentation of the data collection methodologies and statistical analyses used in all the participating countries is available in technical and quality control reports published by the TIMSS International Study Center at Boston College.[10] A list of additional TIMSS reports published to date is contained in Appendix 7.

COMPARING THE UNITED STATES TO OTHER COUNTRIES

Some have argued that comparisons of the performance of U.S. students with students in other countries are inappropriate. One argument is that, in the United States, larger portions of a given age cohort are enrolled in the education system—particularly at the secondary level—than in other countries, resulting in a comparison between our general population and more select groups in other countries. Another argument is that in international comparisons, while the United States tests a sample representative of our general student population, some countries test only those students in elite, college preparatory schools or courses of study. Although these arguments may have been valid in previous studies, neither holds true in TIMSS.

As is discussed in more detail in Chapter 4, the most recent data indicate that in most countries participating in TIMSS, secondary school enrollment rates are similar to that of the United States. **Not only do the TIMSS countries have most of their secondary school-age population enrolled in school, the strict quality controls discussed earlier ensured that the sample of students taking the mathematics and science general knowledge assessments were representative of the entire population at the end of secondary school.** Thus, for example, in most countries with distinct education "streams," such as academic and vocational, students in all programs were represented in the TIMSS sample. **This represents an improvement over previous studies of secondary school achievement, in which some countries only assessed students in certain types of schools or programs.**

Of course, there are still many other differences between the secondary school systems of the countries participating in TIMSS. However, since a major goal of this component of TIMSS was to assess how well people entering adulthood understand the mathematics and science needed to function effectively in society, comparing students at the end of secondary school is entirely appropriate. This is because the end of secondary

school represents the culmination of each country's attempts to prepare all young people for living in society. Rather than use differences between systems to argue against comparisons, or, at the other extreme, ignore such differences, their relationship to mathematics and science achievement should be explored.

THE TIMSS RESEARCH TEAM

TIMSS was conducted by the IEA, which is a Netherlands-based organization of ministries of education and research institutions from its member countries. The IEA delegated responsibility for overall coordination and management of the TIMSS study to Albert Beaton at the TIMSS International Study Center, located at Boston College. Each of the IEA member nations that made the decision to participate in TIMSS paid for and carried out the data collection in its own country according to the international guidelines. The cost of the international coordination was paid by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation (NSF), and the Canadian Government.

The United States portion of TIMSS was also funded by NCES and NSF. William Schmidt of Michigan State University was the U.S. National Research Coordinator. Policy decisions on the study were made by the U.S. National Coordinating Committee. NCES monitored the international and U.S. TIMSS projects. The U.S. data collection was carried out by Westat, a private survey research firm. Trevor Williams and Nancy Caldwell were Westat project co-directors. The many advisors to the study are listed in Appendix 6.

The U.S. TIMSS team also included the approximately 10,000 twelfth-grade students who took the assessments, and their principals in 210 schools nationwide. Their cooperation has made this report possible.

WHAT QUESTIONS DOES THIS REPORT ANSWER?

This report answers three basic questions:

- How does the mathematics and science general knowledge of U.S. twelfth graders compare to that of students completing secondary school in other nations?
- How do U.S. high school seniors with instruction in physics and advanced mathematics perform in these subjects in comparison to advanced science and mathematics students in other nations?
- What factors might contribute to the performance of the United States relative to other countries in mathematics and science at the end of secondary school?

Chapter 2 answers the first question. This question is important because it measures what our students know at the end of secondary school compared to similar students in other nations. The findings in this chapter reveal how well our students have been prepared by 12 years of formal schooling for their future as adults in a world that increasingly relies on mathematics, science, and technology.

Chapter 3 answers the second question. Advanced students had taken or were taking higher level mathematics and

science courses in secondary school, such as calculus and physics. Many are likely to become our nation's next generation of professionals in fields related to mathematics and science.

Chapter 4 answers the third question. It examines a variety of factors related to schooling and students' lives to see if any of them provide insight into why U.S. students perform as they do relative to students in other countries at the end of secondary school.

CHAPTER 2: ACHIEVEMENT OF ALL STUDENTS

KEY POINTS:

U.S. twelfth graders scored below the international average and among the lowest of the 21 TIMSS nations in both mathematics and science general knowledge in the final year of secondary school.

U.S. students' international standing was stronger at the eighth grade than at the twelfth grade in both mathematics and science.

The United States was one of three countries that did not have a significant gender gap in mathematics general knowledge at the end of secondary schooling. While there was a gender gap in science general knowledge in the United States, as in all the other TIMSS countries except one, the U.S. gender gap was one of the smallest.

The U.S. international standing on the general knowledge component of TIMSS was stronger in science than in mathematics. This pattern is similar to the findings at fourth and eighth grades in TIMSS.

MATHEMATICS AND SCIENCE GENERAL KNOWLEDGE

How well do young people understand the basic mathematics and science needed to function effectively in society? To answer this question, TIMSS developed assessments of mathematics and science general knowledge. These assessments were designed to determine students' general level of knowledge of fundamental scientific and mathematical concepts at the time they complete secondary education. These assessments were given to a random sample of all students at the grade set by their nation or program of studies as the end of their secondary schooling, regardless of whether or not they were currently taking mathematics or science at the time of the study.

Because the assessments were designed to examine how well students had acquired the mathematical and scientific skills and knowledge judged by an international committee of experts to be necessary for all citizens in their daily life, the questions asked of the students were not tied to school curriculum. Instead, they covered the students' knowledge of mathematical and scientific concepts, reasoning, and practical or "real world" applications. The results provide a glimpse of how well-prepared to function in the adult world are the graduates of the education system in the various TIMSS nations.

This report examines the performance of U.S. students relative to students in other participating countries. **Tempting though it may be, reporting U.S. scores by rank alone would be incorrect.** This is because the average scores reported for each country were based on a sample of students in each country, and are therefore estimates of the "true" scores that would have been achieved had all the eligible students participated in the assessments.

While many steps were taken to ensure that the samples were representative of the total population, each estimated score has a margin of error associated with it. The margin of error is expressed as a "plus or minus" interval around the estimated score, creating a range of scores within which the true score is likely to fall. Thus, while one score may be higher than another, if the difference between the two is small enough, it may fall within the margin of error and not be statistically significant. Because precise scores cannot be determined with perfect accuracy, to fairly compare the United States to other countries, **nations have been grouped into broad bands according to whether their performance was significantly higher than, not significantly different from, or significantly lower than the United States.**

In TIMSS, we can say with 95 percent confidence that comparisons of other countries' scores on the general knowledge assessments to those of the United States are accurate plus or minus about 12 to 36 points, depending on the size and design of the samples in other countries. Comparisons of the United States to the international average are accurate plus or minus about 7 points. (Table A2.1 in Appendix 2 contains a list of national averages and standard errors.)

FIGURE 1:
MATHEMATICS GENERAL KNOWLEDGE ACHIEVEMENT

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
(NETHERLANDS)	560
SWEDEN	552
(DENMARK)	547
SWITZERLAND	540
(ICELAND)	534
(NORWAY)	528
(FRANCE)	523
NEW ZEALAND	522
(AUSTRALIA)	522
(CANADA)	519
(AUSTRIA)	518
(SLOVENIA)	512
(GERMANY)	495
HUNGARY	483

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(ITALY)	476
(RUSSIAN FEDERATION)	471
(LITHUANIA)	469
CZECH REPUBLIC	466
(UNITED STATES)	**461**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(CYPRUS)	446
(SOUTH AFRICA)	356

INTERNATIONAL AVERAGE = 500

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 2.1. Chestnut Hill, MA: Boston College.

MATHEMATICS GENERAL KNOWLEDGE ASSESSMENT

The mathematics general knowledge assessment consists of about 80 percent multiple choice items and 20 percent free-response items. **Items were chosen based on their likelihood of arising in real-life situations and not on their connection to a particular curriculum.** However, they can be described in terms of common mathematics curriculum topics, such as number sense, including fractions, percentages, and proportionality; algebraic sense; measurement and estimation; and data representation. On average, for the countries participating in the TIMSS assessment of mathematics general knowledge, these topics are typically covered in about the seventh grade.

How Well Do U.S. Twelfth Graders Do On The Mathematics General Knowledge Assessment?

On the mathematics portion of the general knowledge assessment, U.S. students scored below the international average, and among the lowest of the 21 countries. Figure 1 shows how U.S. students performed on the mathematics general knowledge assessment.

In mathematics general knowledge, students in the final year of secondary school in 14 countries scored above our twelfth graders (the Netherlands, Sweden, Denmark, Switzerland, Iceland, Norway, France, New Zealand, Australia, Canada, Austria, Slovenia, Germany, and Hungary). Students in 4 countries were not significantly different from ours (Italy, the Russian Federation, Lithuania, and the Czech Republic). Students in two countries (Cyprus and South Africa) performed significantly below students in the United States.

One explanation for our low performance that has been suggested in the past is that, because of our diverse population, there is a greater range of scores among U.S. students, and the difference between our lowest-scoring students and our typical student is greater than in many other countries. These low-scoring students, it has been argued, "bring down" the U.S. average. Available information suggests that this is not the case in TIMSS.[A]

Looking at the distribution of scores can also illustrate the relatively low position of the United States in TIMSS. The entire distribution of U.S. scores is shifted downward from that of many of the high performing countries. For example, **while a quarter of U.S. students scored 521 or higher, in many high-performing countries half or more of the students had scores that high.** Furthermore, the scores of U.S. students at the 95th percentile were similar to those of students at the 75th percentile in some countries. (See Table A2.3 in Appendix 2 for percentiles for mathematics general knowledge; see Tables A2.4, A2.5, and A2.6 for percentiles for the other assessments.)

What Were Students Asked To Do On The Mathematics General Knowledge Assessment?

Mathematics general knowledge assessment items were designed to measure general knowledge and skills judged by an international committee of experts to be necessary for citizens in their daily life. Three examples of mathematics general knowledge assessment items are shown. Table A3.1 in Appendix 3 shows the percentage of students responding correctly to each example item in every country.

The item shown in Figure 2 requires students to use complex procedures to solve a percentage problem. Fifty-seven percent of U.S. twelfth graders responded correctly to this item. The international average was 64 percent correct. Some students who responded incorrectly chose "C," which is simply the difference of the two percentages, rather than correctly taking the product of the percentages.

The item shown in Figure 3 requires students to provide their response in an open-ended format. Eighty-five percent of U.S. students responded correctly on this item. The international average was 74 percent. Students needed to be able to read the line graph and use the labeled information on the vertical axis to provide the correct answer of 60 km/h as the car's maximum speed.

[A] Specifically, the difference between students with a median score (fiftieth percentile) and those at the fifth percentile is 129 points in the United States; looking at all countries, the average difference between fifth and fiftieth percentiles is 137 points. In addition, the difference between the scores of students at the fifth and ninety-fifth percentiles is similar in most countries. In the United States, 296 points separate these two groups of students, and the average difference is 292 for all 21 countries.

FIGURE 2:

EXAMPLE 1: MATHEMATICS GENERAL KNOWLEDGE ITEM

Experts say that 25% of all serious bicycle accidents involve head injuries and that, of all head injuries, 80% are fatal.

What percent of all serious bicycle accidents involve fatal head injuries?

A. 16%
B. 20%
C. 55%
D. 105%

Correct Answer: B *U.S. Average:* ***57 percent*** *International Average:* ***64 percent***

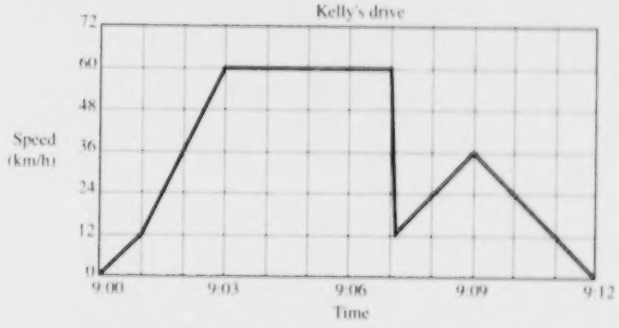
SOURCE: Third International Mathematics and Science Study, 1994-1995.

FIGURE 3:

EXAMPLE 2: MATHEMATICS GENERAL KNOWLEDGE ITEM

Kelly went for a drive in her car. During the drive, a cat ran in front of the car. Kelly slammed on the brakes and missed the cat.

Slightly shaken, Kelly decided to return home by a shorter route. The graph below is a record of the car's speed during the drive.



What was the maximum speed, in kilometers per hour, of the car during the drive?

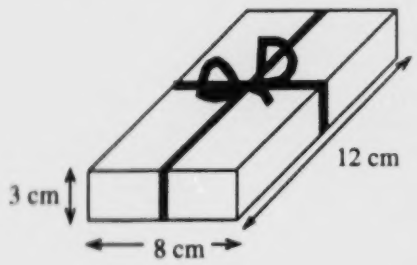
Correct Answer: 60 km/h *U.S. Average:* ***85 percent*** *International Average:* ***74 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995.

FIGURE 4:

EXAMPLE 3: MATHEMATICS GENERAL KNOWLEDGE ITEM

Stu wants to wrap some ribbon around a box as shown below and have 25 centimeters left to tie a bow.



How long a piece of ribbon does he need?

A. 46 cm
B. 52 cm
C. 65 cm
D. 71 cm
E. 77 cm

Correct Answer: E *U.S. Average:* ***32 percent*** *International Average:* ***45 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995

The item in Figure 4 requires students to use the dimensions of a figure to solve a problem. Thirty-two percent of U.S. twelfth graders answered this item correctly. The international average was 45 percent. Some students who responded incorrectly forgot to take into account in their calculations the sides of the box that are not visible in the diagram or the 25 centimeters of ribbon needed to tie a bow.

How Does U.S. Twelfth-Grade Students' Relative Performance In Mathematics Compare To That Of U.S. Eighth-Grade Students?

The group of countries participating in each phase of TIMSS differed. However, 20 of the 21 countries participating in the general knowledge assessments in the final year of secondary schooling also participated in the middle school portion of TIMSS. We can calculate an international average for mathematics achievement of students in these 20 countries both for eighth grade and for

the final year of secondary schooling. (This international average will differ from that based on all countries participating in TIMSS at each grade level—41 in eighth grade and 21 for the final year of secondary schooling. The average U.S. eighth grade mathematics performance is below the international average when the international average is based on all 41 countries participating in TIMSS at eighth grade, but is similar to the international average based on those 20 countries that also participated in the general knowledge assessments at the end of secondary schooling.) Table A5.1 in Appendix 5 shows the standing of each country relative to the 20-country international average for the two grade levels and whether that relative standing was different at the two grade levels. (See Table A5.2 in Appendix 5 for a similar comparison for the 12 countries that participated in TIMSS both at fourth grade and in the general mathematics knowledge assessment at the end of secondary school.)

The relative standing of U.S. students in mathematics was lower at twelfth grade than at eighth grade. About half the countries had a similar standing relative to the international average at both grade levels. The other half were about equally divided between those with a higher and a lower relative standing in the final year of secondary schooling than in eighth grade. The former group was composed of Nordic countries plus New Zealand, while the latter included countries from the former Communist Bloc and Australia, in addition to the United States.

Is There A Gender Gap In Mathematics General Knowledge At The Twelfth Grade?

In the United States and other countries, policy makers have made great efforts to make mathematics and science more accessible to females, and to encourage gender equity in these subjects. Despite these efforts, students in the final year of secondary school in most TIMSS nations demonstrated a significant gender gap in the mathematics portion of the general knowledge assessment, with males performing better than females. **In the United States, boys' and girls' scores in mathematics general knowledge were not significantly different.** The United States was one of three countries (in addition to South Africa and Hungary) among the TIMSS nations which did not have a significant gender gap in mathematics performance (see Table A5.3 in Appendix 5).

Has The Relative International Standing Of The United States In Mathematics At The End Of Secondary School Changed Over Time?

International comparisons over time are difficult. The first international studies of mathematics and science achievement were conducted in the 1960s, and there have been other assessments in each subject since then. However, each assessment has been done differently. A different set of nations participated, different topics in mathematics and science were included in the assessments, the age and type of students sampled in each country changed slightly, and indeed even the borders and names of some of the nations have changed. Furthermore, the field of assessment has

matured greatly over the past 30 years, having made many improvements upon the methods of the then-revolutionary early studies. These and other factors complicate comparisons over time and require that any conclusions be necessarily tentative.

In TIMSS, we have seen that U.S. twelfth graders scored below the international average in mathematics general knowledge, and among the lowest of all nations. This international standing was similar to the one reported for U.S. twelfth graders in the IEA First and Second International Mathematics Studies conducted in the 1960s and 1980s. **Thus, relative to their international counterparts completing secondary school, it is unlikely that U.S. twelfth graders' standing has changed significantly in mathematics achievement over the past 30 years.**

SCIENCE GENERAL KNOWLEDGE ASSESSMENT

The science portion of the general knowledge assessment consisted of about 60 percent multiple choice items and 40 percent free-response items. **Items were chosen based on their likelihood of arising in real-life situations and not on their connection to a particular curriculum.** Looked at in terms of common science curriculum topics, however, the items covered the topics of earth science, life science, and physical science. On average, for the countries participating in the TIMSS assessment of science general knowledge, these topics are typically covered in about the ninth grade.

How Well Do U.S. Twelfth Graders Do On The Science General Knowledge Assessment?

On the science portion of the general knowledge assessment, U.S. students scored below the international average, and among the lowest scoring of the 21 countries. Figure 5 shows how U.S. students performed on the science general knowledge assessment.

On the assessment of science general knowledge, students at the end of secondary school in 11 countries (Sweden, the Netherlands, Iceland, Norway, Canada, New Zealand, Australia, Switzerland, Austria, Slovenia, and Denmark) outperformed U.S. twelfth graders. Students in 7 countries performed not significantly different from those in the United States (Germany, France, the Czech Republic, the Russian Federation, Italy, Hungary, and Lithuania). Students in Cyprus and South Africa performed below students in the United States.

What Were Students Asked To Do On The Science General Knowledge Assessment?

Three examples of TIMSS science general knowledge assessment items are presented. Table A3.1 in Appendix 3 shows the percentage of students in every participating country responding correctly to each of these example items.

The item shown in Figure 6 requires students to apply scientific principles to develop explanations. Forty-two percent of U.S. students responded correctly to this item. The international average was 61 percent correct. Some students'

FIGURE 5:

Science General Knowledge Achievement

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
SWEDEN	559
(NETHERLANDS)	558
(ICELAND)	549
(NORWAY)	544
(CANADA)	532
NEW ZEALAND	529
(AUSTRALIA)	527
SWITZERLAND	523
(AUSTRIA)	520
(SLOVENIA)	517
(DENMARK)	509

INTERNATIONAL AVERAGE = 500

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(GERMANY)	497
(FRANCE)	487
CZECH REPUBLIC	487
(RUSSIAN FEDERATION)	481
(UNITED STATES)	**480**
(ITALY)	475
HUNGARY	471
(LITHUANIA)	461

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(CYPRUS)	448
(SOUTH AFRICA)	349

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 2.2. Chestnut Hill, MA: Boston College.

FIGURE 6:

Example 4: Science General Knowledge Item

Some high-heeled shoes are claimed to damage floors. The base diameter of these very high heels is about 0.5 cm and of ordinary heels about 3 cm. Briefly explain why the very high heels may cause damage to floors.

Correct Answer Examples:

- *"The pressure from the heel is greater because the area is smaller."*
- *"Because of the narrow diameter of very high heels, all the body weight is spread over a smaller area. There is greater pressure exerted on the floor with the higher heels because it is all placed on a small area. The pressure is less on a wider heel because the weight is distributed over a greater area causing less damage."*

U.S. Average: ***42 percent*** *International Average:* ***61 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995.

FIGURE 7:

EXAMPLE 5: SCIENCE GENERAL KNOWLEDGE ITEM

CFCs (chlorofluorocarbons) revolutionized personal and industrial life for 30 years. They were the coolant in refrigerators and the propellants in aerosols, pressure packs, and fire extinguishers. There are now very strong international moves to stop the use of these substances because:

A. they are chemically inert.
B. they contribute to the greenhouse effect.
C. they are poisonous to humans.
D. they destroy the ozone layer.

Correct Answer: D *U.S. Average:* **78 percent** *International Average:* **77 percent**

SOURCE: Third International Mathematics and Science Study, 1994-1995.

incorrect responses, such as "because they are sharper and poke into the floor," attributed the damage to sharpness rather than the effects of pressure placed on a small surface area.

The item shown in Figure 7 requires an understanding of causes of pollution. Seventy-eight percent of U.S. twelfth graders responded correctly on this item. The international average was 77 percent.

The item shown in Figure 8 requires knowledge of complex information about the interdependence of life. The U.S. average was 40 percent correct, and the international average was 37 percent. Some students who responded incorrectly to this item were not sufficiently explicit about how a species can regulate the population of its prey.

How Does U.S. Twelfth-Grade Students' Relative Performance In Science Compare To That Of U.S. Eighth-Grade Students?

As in mathematics, it is possible to compare the science performance of all U.S. students at both eighth grade and in the final year of secondary school to the group of 20 countries that participated in both of these portions of TIMSS. Table A5.4 in Appendix 5 displays the standing for each country relative to the international average for science achievement for the two grade levels based on the 20 countries and whether that relative standing was different at the two grade levels. (See Table A5.5 in Appendix 5 for a similar comparison for the 12 countries that participated in TIMSS both at fourth grade and in the science general knowledge assessment at the end of secondary school.)

FIGURE 8:
EXAMPLE 6: SCIENCE GENERAL KNOWLEDGE ITEM

When an animal or plant species is introduced to an area where it has never previously existed, it frequently creates a problem by multiplying out of control and displacing established species. One way of fighting introduced species is to poison them. This may be impractical, be very costly or carry heavy risks. Another method, called *biological control*, involves the use of living organisms, other than human beings, to control the pest species.

Give an actual example of a biological control.

Correct Answer Examples:

- *"Have a house cat in your house to rid mice as a biological control."*
- *"Ladybugs are introduced to eat aphids."*

U.S. Average: ***40 percent*** *International Average:* ***37 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995.

In science, the United States is one of 7 countries where the standing relative to the international average was lower at the end of secondary schooling than it was at eighth grade. The others were former Communist Bloc countries plus Australia and Germany. Eight countries had a similar standing relative to the international average at both grade levels and 5 had a higher relative standing in the final year of secondary schooling than in eighth grade.

Is There A Gender Gap In Science General Knowledge At The Twelfth Grade?

In the United States, there was a gender gap on the science portion of the twelfth-grade general knowledge assessment. Excluding South Africa, in all other TIMSS nations, including the United States, males performed significantly better than females in science. However, among those countries, **the U.S. gender gap in science was one of the smallest** (see Table A5.6 in Appendix 5).

Has The Relative International Standing Of The United States In Science At The End Of Secondary School Changed Over Time?

In TIMSS, we have seen that U.S. twelfth graders scored below the international average in science, and among the lowest of all nations. This is basically the same relative international standing reported for U.S. twelfth graders in the IEA First and Second International Science Studies in the 1960s and 1980s. **Thus, relative to their international counterparts in the final year of secondary school, it is unlikely that U.S. twelfth graders' standing has changed significantly in science.**

How Does The Performance Of U.S. Twelfth Graders In Science Compare To Their Performance In Mathematics?

Although U.S. students scored below the international average and among the lowest of TIMSS nations on both portions of the general knowledge assessments, **the U.S. international standing on the general knowledge assessments was slightly higher in science than it was in mathematics.** Fourteen countries were significantly higher than the United States in the mathematics general knowledge assessment, while 11 countries outperformed the United States in science general knowledge. This pattern is similar to the fourth- and eighth-grade TIMSS results, in which the U.S. relative international standing was higher in science than it was in mathematics.

Among the major trading partners of the United States that participated in TIMSS at the end of secondary school, students in Canada outperformed the U.S. in both mathematics and science general knowledge. Students in France and Germany outperformed U.S. students in mathematics general knowledge, and performed similar to U.S. students in science.

We have now examined what TIMSS tells us about all students in their final year of secondary school. Next, we turn to an examination of how the advanced students in the United States who were taking or had taken advanced courses in mathematics and science compared to their counterparts in other TIMSS nations.

CHAPTER 3: ACHIEVEMENT OF ADVANCED STUDENTS

KEY POINTS:

The performance of U.S. physics and advanced mathematics students was among the lowest of the 16 countries that administered the physics and advanced mathematics assessments.

In all five content areas of physics and in all three content areas of advanced mathematics, U.S. physics and advanced mathematics students' performance was among the lowest of the TIMSS nations.

In both physics and advanced mathematics, males outperformed females in the United States. This was true for 4 of the 5 content areas in physics and for all 3 of the content areas in advanced mathematics.

More countries outperformed the United States in physics than in advanced mathematics. This differs from results for mathematics and science general knowledge, where more countries outperformed the United States in mathematics than in science.

Chapter 2 has shown us how U.S. twelfth graders performed in mathematics and science general knowledge in comparison to students at the close of their secondary school studies in other countries. It shows us the level of general mathematics and scientific knowledge of the entire sampled student population. But because advances in science and technology are playing a greater role in shaping the future of our nation and our world, it is useful to look beyond the general levels of science and mathematics general knowledge and focus on the advanced levels of knowledge of those who are likely to become our next generation of professionals in fields related to mathematics and science.

Therefore, in addition to the TIMSS assessments of science and mathematics general knowledge, other assessments were created to compare the achievement of students taking advanced science and mathematics courses. Physics was selected by the participating countries for the advanced science assessment because "it is the branch of science most closely associated with mathematics," and because it was viewed as coming "closest to the essential elements of natural science."[11] Students were allowed to use calculators on the assessments and relevant formulas were provided.

The numbers of students participating in the physics and advanced mathematics assessments were generally much smaller (one-third to one-half as many) than in the mathematics and science general knowledge assessments. As a result, estimates of a country's average scores in the physics and advanced mathematics assessments have larger margins of error than in the mathematics and science general knowledge assessments. We can say with 95 percent confidence that comparisons of other countries' scores to those of the United States are accurate plus or minus 20 to 40 points on advanced mathematics, and 15 to 65 points on physics, depending on the size and design of the samples in other countries. Comparisons of the United States with the international average are accurate plus or minus about 12 points for advanced mathematics and 7 points for physics. (Table A2.2 in Appendix 2 contains a list of national average scores and standard errors.)

ADVANCED MATHEMATICS ASSESSMENT

An assessment of advanced mathematics was given to a sample of students taking advanced coursework in mathematics. In the United States, these were students who had taken or were taking a full year of a high school course that included the word "calculus" in the title. This included calculus, pre-calculus, Advanced Placement calculus, and calculus and analytic geometry. It should be noted, however, that the advanced mathematics assessment was not primarily a calculus assessment. **About one-quarter of the items were in the content area of calculus. Other content areas included in the assessment were: numbers, equations, and functions; validation and structure; probability and statistics; and geometry.** Sub-scales were created for the geometry; calculus; and numbers, equations, and functions content areas. The number of items in the other two categories was too small to obtain

reliable scores so separate sub-scales were not developed for them. On the advanced mathematics assessment, three-quarters of the items were multiple choice and one-quarter free response.

Fewer countries participated in the advanced mathematics assessment than in the general knowledge assessments. Among the 21 countries which participated in the mathematics and science general knowledge assessments, six countries (Hungary, Iceland, the Netherlands, New Zealand, Norway, and South Africa) did not administer the advanced mathematics assessment. Greece, which did not participate in the mathematics and science general knowledge assessments, participated in the advanced mathematics assessment. As a result, 16 countries participated in the advanced mathematics assessment.

The goal of the advanced mathematics assessment was to compare the mathematics performance of students in the most advanced 10 to 20 percent of their age cohort across nations. Countries were asked to identify these students using definitions appropriate for their own education systems. In the United States, in order to meet the criterion of representing 10 to 20 percent of the age cohort, students whose highest mathematics course was pre-calculus were included along with students who had studied or were studying calculus.

In two countries, the Russian Federation and Lithuania, the advanced mathematics students constituted less than 5 percent of their age cohort; in Austria, Germany, and Slovenia, they constituted more than 20 percent. In the remaining 11 countries—including the United States—students in the advanced mathematics assessment were representative of about 10 to 20 percent of their age cohort. Table A5.7 in Appendix 5 contains the estimated percentages of the age cohort in each country represented by students who took the advanced mathematics assessment.

How Do Our Twelfth Graders With Advanced Mathematics Instruction Compare To Advanced Mathematics Students In Other Countries?

The performance of U.S. twelfth-grade advanced mathematics students was among the lowest of the 16 TIMSS nations who administered the assessment to a comparable population of their advanced mathematics students and below the international average. Figure 9 shows that 11 nations outperformed the United States, while U.S. scores were not significantly different from those of 4 other nations. **No countries scored below the United States on the assessment of advanced mathematics.**

U.S. advanced mathematics students included those who had completed or were completing pre-calculus, calculus, calculus and analytic geometry, or Advanced Placement calculus, representing about 14 percent of the school-completing age cohort in the United States. If we compared only those U.S. students who had taken or were taking calculus or Advanced Placement calculus against all the advanced mathematics students in other countries, how did our calculus students perform?

FIGURE 9:

Average Advanced Mathematics Performance of Advanced Mathematics Students in All Countries

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
FRANCE	557
(RUSSIAN FEDERATION)	542
SWITZERLAND	533
(AUSTRALIA)	525
(DENMARK)	522
(CYPRUS)	518
(LITHUANIA)	516
GREECE	513
SWEDEN	512
CANADA	509
(SLOVENIA)	475

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(ITALY)	474
CZECH REPUBLIC	469
(GERMANY)	465
(UNITED STATES)	**442**
(AUSTRIA)	436

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
NONE	

INTERNATIONAL AVERAGE = 501

NOTE: Nations not meeting international sampling or other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 5.1. Chestnut Hill, MA: Boston College.

How Do U.S. Twelfth Graders With Calculus Or Advanced Placement Calculus Compare To All Advanced Mathematics Students In Other Countries?

U.S. twelfth graders with calculus or Advanced Placement calculus instruction represented about 7 percent of the U.S. age cohort. These students did perform better in the assessment than the larger U.S. group that also included students whose highest course was pre-calculus.

Advanced mathematics students in 6 countries (France, the Russian Federation, Switzerland, Denmark, Cyprus, and Lithuania) outperformed calculus and AP calculus students in the U.S. Figure 10 shows that the performance of U.S. twelfth graders with calculus or Advanced Placement calculus instruction was not significantly different from the international average and 7 of the 16 TIMSS nations that administered the assessment to their advanced mathematics students. Our scores were significantly higher than those of two other nations (Germany and Austria).

FIGURE 10:

AVERAGE ADVANCED MATHEMATICS PERFORMANCE OF ADVANCED MATHEMATICS STUDENTS IN OTHER COUNTRIES COMPARED WITH U.S. CALCULUS AND AP CALCULUS STUDENTS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
FRANCE	557
(RUSSIAN FEDERATION)	542
SWITZERLAND	533
(DENMARK)	522
(CYPRUS)	518
(LITHUANIA)	516

INTERNATIONAL AVERAGE = 504

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(AUSTRALIA)*	525
GREECE	513
SWEDEN	512
CANADA	509
(UNITED STATES)	**492**
(SLOVENIA)	475
(ITALY)	474
CZECH REPUBLIC	469

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(GERMANY)	465
(AUSTRIA)	436

*The placement of Australia may appear out of place; however, statistically its placement is correct.

NOTE: Nations not meeting international sampling or other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 5.1. Chestnut Hill, MA: Boston College, and unpublished tabulations.

The performance of U.S. twelfth graders with Advanced Placement calculus instruction, who represent about 5 percent of the U.S. age cohort was significantly higher than the performance of advanced mathematics students in 5 other countries. Figure 11 shows that one nation (France) outperformed the United States, while our scores were not significantly different from 9 other countries and the international average. Thus, the most advanced mathematics students in the United States, about 5 percent of the total age cohort, performed similarly to 10 to 20 percent of the age cohort in most of the other countries.

How Do U.S. Students Score In The Different Content Areas Of Advanced Mathematics?

Representing student achievement in advanced mathematics as a total score is a useful way to summarize achievement. However, the advanced mathematics assessment contained different content areas, which are emphasized and sequenced differently in curricula around the world. Based on national priorities, some content areas have been studied more than others in different countries by the time these students are ready to graduate from secondary school.

FIGURE 11:

Average Advanced Mathematics Performance of Advanced Mathematics Students In Other Countries Compared With U.S. AP Calculus Students

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**AVERAGE**
FRANCE	557

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**AVERAGE**
(RUSSIAN FEDERATION)	542
SWITZERLAND	533
(AUSTRALIA)	525
(DENMARK)	522
(CYPRUS)	518
(LITHUANIA)	516
(UNITED STATES)	**513**
GREECE	513
SWEDEN	512
CANADA	09

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.	
NATION	**AVERAGE**
(SLOVENIA)	475
(ITALY)	474
CZECH REPUBLIC	469
(GERMANY)	465
(AUSTRIA)	436

INTERNATIONAL AVERAGE = 505

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 5.1. Chestnut Hill, MA: Boston College, and unpublished tabulations.

The TIMSS advanced mathematics assessment included sets of items designed to sample students' ability to do work in the following areas:

Numbers, Equations, and Functions:
Complex numbers and their properties; permutations and combinations; equations and formulas; and patterns, relations, and functions.

Calculus:
Infinite processes; and change.

Geometry:
Basic geometry; coordinate geometry; polygons and circles; and three-dimensional geometry.

Figure 12 shows that in all of the content areas of advanced mathematics, U.S. students' performance was among the lowest of the TIMSS nations.

Among the content areas, U.S. students' performance was relatively weakest in

FIGURE 12:

Achievement in Advanced Mathematics Content Areas

NUMBERS & EQUATIONS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
(RUSSIAN FEDERATION)	555
FRANCE	548
(LITHUANIA)	547
GREECE	539
SWEDEN	523
(AUSTRALIA)	517
SWITZERLAND	514
(CANADA)	512
(CYPRUS)	510
(DENMARK)	504
(SLOVENIA)	491

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
CZECH REPUBLIC	460
(ITALY)	460
(UNITED STATES)	**459**
(GERMANY)	457

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(AUSTRIA)	412

INTERNATIONAL AVERAGE = 501

CALCULUS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
(CYPRUS)	561
FRANCE	560
GREECE	538
(RUSSIAN FEDERATION)	537
(AUSTRALIA)	530
(ITALY)	520
SWITZERLAND	512
(DENMARK)	508
(CANADA)	503
(LITHUANIA)	498
SWEDEN	480

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(SLOVENIA)	471
(GERMANY)	454
(UNITED STATES)	**450**
CZECH REPUBLIC	446

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(AUSTRIA)	439

INTERNATIONAL AVERAGE = 501

GEOMETRY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
(RUSSIAN FEDERATION)	548
SWITZERLAND	547
FRANCE	544
(DENMARK)	527
(CYPRUS)	517
(LITHUANIA)	515
(CANADA)	499
GREECE	498
(AUSTRALIA)	496
CZECH REPUBLIC	494
SWEDEN	492
(GERMANY)	487
(ITALY)	480
(SLOVENIA)	476
(AUSTRIA)	462

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(UNITED STATES)	**424**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
NONE	

INTERNATIONAL AVERAGE = 500

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

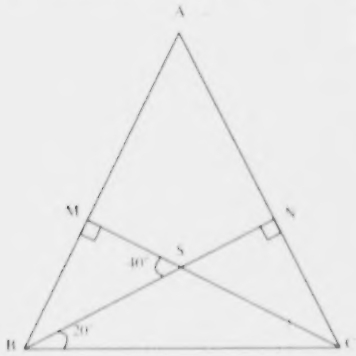
SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 6.1. Chestnut Hill, MA: Boston College.

FIGURE 13:
EXAMPLE 7: GEOMETRY ITEM

In the ΔABC, shown below, the altitudes BN and CM intersect at point S. The measure of the $\angle MSB$ is 40° and the measure of $\angle SBC$ is 20°. Write a PROOF of the following statement:

"ΔABC is isosceles."

Give geometric reasons for statements in your proof.



Correct Answer Example:

Correct proof proves that $\angle B = \angle C$, using the following facts:

- *the sum of angles in any triangle is 180°*
- *if two angles of a triangle are equal, the triangle is isosceles*
  also may include:
  —vertically opposite angles are equal
  —supplementary angles add to 180°

U.S. Average: ***19 percent*** *International Average:* ***48 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995.

geometry: no country scored similar to or below the United States. In numbers, equations, and functions, as well as in calculus, fewer countries (11 countries) scored above the United States. See Table A4.1 in Appendix 4 for U.S. AP and non-AP calculus students' scores by content area.

What Were Students Asked To Do On The Advanced Mathematics Assessment?

There are three examples of advanced mathematics assessment items. Table A3.2 in Appendix 3 shows the percentage of students in every country responding correctly to each of these example items.

An example of a geometry item is shown in Figure 13. This item required

FIGURE 14:
EXAMPLE 8: PROBABILITY AND STATISTICS ITEM

A set of 24 cards is numbered with the positive integers from 1 to 24. If the cards are shuffled and if only one is selected at random, what is the probability that the number on the card is divisible by four or six?

A $\frac{1}{6}$

B $\frac{5}{24}$

C $\frac{1}{4}$

D $\frac{1}{3}$

E $\frac{5}{12}$

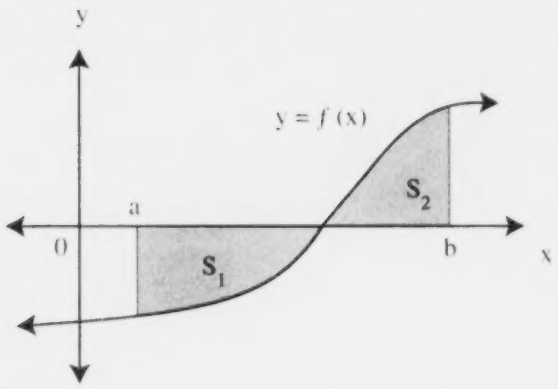
Correct Answer: D *U.S. Average:* ***62 percent*** *International Average:* ***50 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995

students to prove and justify the given statement. The international average for this item was 48 percent. Nineteen percent of U.S. students responded at least partially correctly. Over one-third of U.S. students did not receive credit for this item due to incorrect argumentation and/or including more than one incorrect geometric fact, step, or reason. Figure 14 is an example of a probability and statistics item. Of U.S. students, 62 percent responded correctly. The international average was 50 percent correct. Some students who responded incorrectly to this item chose "E," perhaps simply counting all of the even numbers between four and twenty-four, rather than correctly counting only the factors of 24 that are divisible by four or six.

The calculus item shown in Figure 15, that required students to demonstrate their understanding of integrals, proved to be a difficult item for most students, including U.S. students. Twenty-seven percent of U.S. students responded correctly to this item, and the international

FIGURE 15:
EXAMPLE 9: CALCULUS ITEM



The figure above shows the graph of $y = f(x)$.
S_1 is the area enclosed by the x-axis, $x = a$, and $y = f(x)$.
S_2 is the area enclosed by the x-axis, $x = b$, and $y = f(x)$.
where $a<b$ and $0<S_2<S_1$.

The value of $\int_a^b f(x)\,dx$ is

A $S_1 + S_2$

B $S_1 - S_2$

C $S_2 - S_1$

D $|S_1 - S_2|$

E $\frac{1}{2}(S_1 + S_2)$

Correct Answer: C *U.S. Average:* **27 percent** *International Average:* **35 percent**

SOURCE: Third International Mathematics and Science Study, 1994-1995

average was about 35 percent. Many students who responded incorrectly apparently did not recognize that if a curve lies above the x-axis, the integral represents the area under the curve, and if the curve lies below the x-axis, the integral represents the negative of the area between the curve and the x-axis.

Is There A Gender Gap In Advanced Mathematics At The Twelfth Grade?

In the United States, twelfth-grade males outperformed twelfth-grade females in advanced mathematics. The United States was one of the 11 TIMSS nations in which a gender gap existed. No significant gender gap existed in the other 5 countries. **For the United States and 7 other countries, there was a significant gender gap existing in all 3 advanced mathematics content areas.** (See Tables A5.8 and A5.9 in Appendix 5.)

PHYSICS ASSESSMENT

The TIMSS physics assessment included questions about mechanics; electricity and magnetism; particle, quantum and other types of modern physics; heat; and wave phenomena. In the United States, the population that took the assessment was twelfth graders who had taken or were taking at least one year-long course in physics. This included physics I, physics II, advanced physics, and Advanced Placement physics.

Fewer countries participated in the physics assessment than in the general knowledge assessments. Among the 21 countries which participated in the mathematics and science general knowledge assessments, 7 countries (Hungary, Iceland, Italy, Lithuania, the Netherlands, New Zealand, and South Africa) did not administer the physics assessment. Greece and Latvia, which did not participate in the general knowledge assessments, participated in the physics assessment. As a result, 16 countries participated in the physics assessment.

In general, countries identified similar percentages of an age cohort as appropriate for the physics assessment. Although countries used their own definitions to identify advanced science students, for 11 of the 16 countries, including the United States, these students represented about 10 to 20 percent of their age cohort. The only exceptions to this pattern were Denmark, Latvia, and the Russian Federation, where physics students represented less than 5 percent of the age cohort, and Austria and Slovenia, where the students represented more than 20 percent of the age cohort. (Table A5.7 in Appendix 5 contains the percentages of the age cohort in each country represented by students who took the physics assessment.)

How Do U.S. Twelfth Graders With Physics Instruction Compare To Advanced Science Students In Other Countries?

The performance of U.S. twelfth-grade physics students was among the lowest of the 16 TIMSS nations that administered the assessment to a comparable population of their students and below the international average. Figure 16 shows that 14 nations outperformed the United States, while our scores were not

FIGURE 16:
Average Physics Performance of Advanced Science Students in All Countries

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
NORWAY	581
SWEDEN	573
(RUSSIAN FEDERATION)	545
(DENMARK)	534
(SLOVENIA)	523
(GERMANY)	522
(AUSTRALIA)	518
(CYPRUS)	494
(LATVIA)	488
SWITZERLAND	488
GREECE	486
(CANADA)	485
FRANCE	466
CZECH REPUBLIC	451

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(AUSTRIA)	435
(UNITED STATES)	**423**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
NONE	

INTERNATIONAL AVERAGE = 501

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 8.1. Chestnut Hill, MA: Boston College.

significantly different from those of one other nation. **No countries scored below the United States on the physics assessment.** One interesting aspect of the scores on the physics assessment is that there was less variation in the scores among U.S. students than in 13 of the other 15 countries. The range of U.S. students scores was relatively narrow—189 points between the 5th and 95th percentile compared to an average difference of 293 points for all 16 countries.

In the United States, the population that took the assessment were twelfth graders who had completed or were completing physics I, physics II, advanced physics, or Advanced Placement physics, representing about 11 percent of the age cohort. If we compared only those U.S. students who had taken or were taking Advanced Placement physics with all the advanced science students in other countries, how did U.S. AP physics students perform?

FIGURE 17:

Average Physics Performance of Advanced Science Students in Other Countries Compared with U.S. AP Physics Students

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
NORWAY	581
SWEDEN	573
(RUSSIAN FEDERATION)	545
(DENMARK)	534
(GERMANY)	522
(AUSTRALIA)	518

INTERNATIONAL AVERAGE = 504

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(SLOVENIA)*	523
(CYPRUS)	494
(LATVIA)	488
SWITZERLAND	488
GREECE	486
(CANADA)	485
(UNITED STATES)	**474**
FRANCE	466
CZECH REPUBLIC	451

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(AUSTRIA)	435

*The placement of Slovenia may appear out of place, however, statistically its placement is correct.

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 8.1. Chestnut Hill, MA: Boston College.

How Do U.S. Twelfth Graders With Advanced Placement Physics Instruction Compare To Advanced Science Students In Other Countries?

U.S. twelfth graders with Advanced Placement physics represented about 1 percent of the age cohort in the United States. **U.S. students who had taken or were taking Advanced Placement physics were outperformed by advanced science students in fewer nations than were the students in our larger group of physics students.** Figure 17 shows that U.S. Advanced Placement physics students scored below the international average and advanced science students in 6 nations, while the average U.S. score was significantly higher than that of one other nation. The performance of U.S. twelfth graders with Advanced Placement physics instruction was no different from the performance of 8 of the 16 TIMSS nations that administered the assessment to their advanced science

students. However, U.S. Advanced Placement physics students represented a much smaller proportion of the age cohort in the United States than did the advanced science students in most of the other countries.

How Do U.S. Students Score In The Different Content Areas Of Physics?

Representing student achievement in physics as a total score is a useful way to summarize achievement. However, the physics assessment contained different content areas, which are emphasized and sequenced differently in curricula around the world. Based on national priorities, and sequencing of physics instruction for advanced students at the secondary level, some content areas have been studied more than others in various countries by the time these students graduate from secondary school.

The TIMSS physics assessment included sets of items designed to sample students' ability to do work in the following areas:

Mechanics: Dynamics of motion; time, space and motion; types of forces; and fluid behavior.

Electricity/magnetism: Electricity; and magnetism.

Heat: Physical changes; energy types, sources and conversions; heat and temperature; and kinetic theory.

Wave phenomena: Sound and vibration; light; and wave phenomena.

Modern physics: Nuclear chemistry; quantum theory and fundamental particles; astrophysics; subatomic particles; and relativity theory.

Figure 18 shows that **in all five physics content areas, U.S. students' performance was among the lowest of the TIMSS nations.** In two content areas, one nation scored below the United States. Students in Austria scored below students in the United States in the content area of heat and students in Cyprus scored below U.S. students in the area of modern physics. Among the content areas, U.S. students performed the poorest in the content areas of mechanics and electricity/magnetism, in terms of the number of countries outperforming the United States. See Table A4.2 in Appendix 4 for U.S. AP and non-AP physics students' scores by content area.

What Were Advanced Science Students Asked To Do On The Physics Assessment?

On pages 56 and 57, there are three examples of physics assessment items. Table A3.2 in Appendix 3 shows the percentage of students in every country responding correctly to each of these example items.

Figure 19 is an example of a mechanics item. Forty-one percent of U.S. physics students responded correctly to this item. The international average was about 70 percent. Some students who responded incorrectly appear not to have recognized that the pressure of the water would cause the horizontal placement of the streams to differ. Figure 20 is an example of a heat item. Forty-nine percent of U.S. physics students chose the correct answer. The international average on this item was 41 percent correct. Many students who responded incorrectly chose "A."

FIGURE 18:
Achievement in Physics Content Areas

MECHANICS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
NORWAY	572
SWEDEN	563
(SLOVENIA)	552
(RUSSIAN FEDERATION)	537
(CYPRUS)	530
(DENMARK)	529
GREECE	514
(AUSTRALIA)	507
(GERMANY)	495
(LATVIA)	489
SWITZERLAND	482
(CANADA)	473
CZECH REPUBLIC	469
FRANCE	457

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(AUSTRIA)	420
(UNITED STATES)	**420**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
NONE	

INTERNATIONAL AVERAGE = 501

ELECTRICITY/MAGNETISM

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
SWEDEN	570
NORWAY	565
(RUSSIAN FEDERATION)	549
GREECE	520
(DENMARK)	513
(AUSTRALIA)	512
(GERMANY)	512
(SLOVENIA)	509
(CYPRUS)	502
FRANCE	494
(CANADA)	485
(LATVIA)	485
SWITZERLAND	480
CZECH REPUBLIC	465

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(AUSTRIA)	432
(UNITED STATES)	**420**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
NONE	

INTERNATIONAL AVERAGE = 501

HEAT

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
NORWAY	536
(RUSSIAN FEDERATION)	530
SWEDEN	522
(SLOVENIA)	521
(AUSTRALIA)	517
(DENMARK)	512
SWITZERLAND	509
(CANADA)	508
FRANCE*	491

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(LATVIA)	504
(GERMANY)	496
CZECH REPUBLIC	488
GREECE	481
(UNITED STATES)	**477**
(CYPRUS)	476

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(AUSTRIA)	445

INTERNATIONAL AVERAGE = 501

FIGURE 18 (CONTINUED): ACHIEVEMENT IN PHYSICS CONTENT AREAS

WAVE PHENOMENA

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
NORWAY	560
SWEDEN	560
(DENMARK)	537
(GERMANY)	530
(AUSTRALIA)	519
(RUSSIAN FEDERATION)	515
(SLOVENIA)	514
(CYPRUS)	507
SWITZERLAND	498
(CANADA)	488

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(LATVIA)*	498
(AUSTRIA)	468
FRANCE	463
GREECE	453
(UNITED STATES)	**451**
CZECH REPUBLIC	447

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
NONE	

INTERNATIONAL AVERAGE = 500

MODERN PHYSICS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	AVERAGE
NORWAY	576
SWEDEN	560
(GERMANY)	545
(DENMARK)	544
(RUSSIAN FEDERATION)	542
(AUSTRALIA)	521
(SLOVENIA)	511
(CANADA)	494
SWITZERLAND	488
(AUSTRIA)	480
FRANCE	474

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	AVERAGE
(LATVIA)*	488
(UNITED STATES)	**456**
CZECH REPUBLIC	453
GREECE	447

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	AVERAGE
(CYPRUS)	434

INTERNATIONAL AVERAGE = 501

*The placement of Latvia on wave phenomena and modern physics, and France on heat, may appear out of place; however, statistically their placement is correct.

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix I for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics Achievement in the Final Year of Secondary School.* Table 9.1. Chestnut Hill, MA: Boston College.

FIGURE 19:
EXAMPLE 10: MECHANICS ITEM

The figure shows a common plastic bottle (1L) filled with water and with three holes in it, so that the water runs out of the holes.

Explain what is wrong with the figure.

Correct Answer Example

- *"The pressure will increase with depth due to water above, so the water jets will have other paths."*

U.S. Average: ***41 percent*** *International Average:* ***70 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995.

FIGURE 20:
EXAMPLE 11: HEAT ITEM

A jar of oxygen gas and a jar of hydrogen gas are at the same temperature.

Which of the following has the same value for the molecules of both gases?

A. the average velocity
B. the average momentum
C. the average force
D. the average kinetic energy

Correct Answer: D *U.S. Average:* ***49 percent*** *International Average:* ***41 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995.

FIGURE 21:
EXAMPLE 12: WAVE PHENOMENA ITEM

A car moving at a constant speed with a siren sounding comes towards you and then passes by. Describe how the frequency of the sound you hear changes.

Correct Answer Examples

- *"The pitch is higher as the car comes closer and lower after it goes by."*
- *"When the car approaches, the wavelength of the sound is shorter than it is when the car moves away."*

U.S. Average: ***12 percent*** *International Average:* ***37 percent***

SOURCE: Third International Mathematics and Science Study, 1994-1995

A third example of a physics item concerns wave phenomena, as shown in Figure 21. This proved to be a difficult item for most students, including U.S. students. Twelve percent of U.S. physics students received at least partial credit for this item, and the international average was approximately 37 percent correct. Some students who responded incorrectly to this item did not adequately distinguish between the loudness of the sound and a change in the wave frequency.

Is There A Gender Gap In Physics At The Twelfth Grade?

In the United States, as in all the other TIMSS nations except Latvia, twelfth-grade males outperformed twelfth-grade females in physics. In the United States, this gender gap existed in 4 of the 5 content areas of physics included in the TIMSS assessment (all except heat). More than three-quarters of the countries had a significant gender gap in the content areas of mechanics, wave phenomena, and modern physics. (See Tables A5.10 and A5.11 in Appendix 5.)

How Does U.S. Student Performance In Physics Compare To That In Advanced Mathematics?

Unlike our performance on the general knowledge portion of the assessment (where U.S. students' relative performance was stronger in science than it was in mathematics), U.S. performance on the physics assessment was weaker relative to other countries than on the advanced mathematics assessment. Fourteen countries scored above the U.S. in the physics assessment, while fewer countries (11 countries) outperformed the U.S. in the advanced mathematics assessment.

The relationship between performance in physics and advanced mathematics might be more similar to the pattern in general knowledge assessments (with students performing better in science than in mathematics) if TIMSS had assessed other content areas of science such as life science or environmental issues and the nature of science, as was done in eighth grade. Among the content areas of the science assessment given to eighth graders, U.S. students' performance was weakest in physics and strongest in life science and in environmental issues and the nature of science.

CHAPTER 4: THE CONTEXT OF LEARNING

KEY POINTS:

It is too early in the process of data analysis to provide strong evidence to suggest factors that may be related to the patterns of performance described here.

While secondary education in the United States differs from that in many of the other countries on important dimensions, few of those differences are clearly related to the relatively poor performance of our twelfth graders on the TIMSS assessments.

The lives of United States graduating students differ from those of their peers in other countries on several of the factors examined. Where there are differences, few appear to be systematically related to U.S. performance in twelfth grade compared to the other countries participating in TIMSS.

Further analyses are needed to provide more definitive insights on these subjects.

Chapters 2 and 3 have portrayed how U.S. high school students in the spring of their senior year performed in mathematics and science compared to their peers at the end of secondary school in many other countries. Generally, the performance of these U.S. students did not compare favorably with that of students in the other countries participating in TIMSS. The results from previous international assessments have generally shown that U.S. performance relative to other countries was lower at higher grade levels and a similar pattern emerged in TIMSS, with the strongest U.S. performance in fourth grade and the poorest at the end of secondary schooling.

This chapter uses data from TIMSS and other sources to examine a number of factors that could contribute to the poor performance of U.S. twelfth graders. Most of the factors examined in this chapter are ones that previous research has shown to be associated with variation in student performance within the United States or which observers have suggested could be associated with differences in performance between countries. (See Appendix 5 for details.)

Since we are primarily interested in identifying factors that might account for the relatively poor performance of U.S. students, we did not use the strategy of looking for factors that account for variation across all the countries. Instead, we used the following two-step process: For each potential explanatory factor, the first step was to determine whether each of the other TIMSS countries were significantly higher or lower or were similar to the United States on that factor. The second step was to examine whether the countries that outperformed the United States differed on that factor from the United States and from countries that performed similarly to or below the United States.[1]

The first section of the chapter examines factors that might be associated with the performance of U.S. twelfth graders on the general knowledge assessments relative to students in other countries. The second section examines factors that might be associated with our relative performance on the physics and advanced mathematics assessments. Both sections are organized in the following manner. First the factors are discussed, focusing on how the United States compares to the other countries on each one. Then, those factors that seem to be related to the U.S. performance compared to the other countries are identified and discussed. (At the end of the first section, there is also a discussion of two factors that might

[1] Such an approach to the data was chosen for this initial analysis in part because the data for individual students were not yet available for any country except the United States. In addition, since the analysis had to be conducted on country-level data, where there were at most 21 cases (i.e., the maximum number of countries for any of the assessments), more sophisticated statistical analysis was unlikely to detect any relationships unless the relationships were very pronounced. Two byproducts of using such an approach should be noted. First, if there are any factors on which the United States differs from all the other countries, those factors cannot explain the U.S. relative performance, since the U.S. would differ on that factor both from the countries that outperformed us and the ones that did not. Second, because the United States was outperformed by all the participating countries except one (Austria) on the physics assessment, we are unlikely to find any factors on which the United States (and Austria) differ from all the other countries. In a few cases, the analysis had only one step, namely to calculate and compare the average for the factor in question (e.g., GNP per capita) for two groups of countries: those that outperformed the United States and those that did not.

be related to the lower relative standing of U.S. students in twelfth grade than in eighth grade.) Figures 25-27 and 29 summarize the findings of these analyses.

To simplify the discussion, the analyses about factors related to U.S. international standing on the general knowledge assessments focused on the mathematics general knowledge assessment, rather than looking both at mathematics and at science general knowledge performance. More countries outperformed the United States in mathematics than in science general knowledge and all the countries that outperformed the United States in science outperformed us in mathematics general knowledge as well.

THE CONTEXT OF LEARNING FOR STUDENTS PARTICIPATING IN THE GENERAL KNOWLEDGE ASSESSMENTS

The way in which countries structure and provide secondary education, or high school as it is known in the United States, differs greatly around the world. Among the nations participating in TIMSS, different policy decisions, cultural beliefs about how best to develop students' potential, and other factors result in differences in secondary education such as school types, enrollment, the courses students take, course curricula, and financial support for schools. In some cases, these differences are more pronounced than in others. **TIMSS provides an opportunity to examine whether these differences in education systems are related to what students know in mathematics and science at the end of their secondary schooling.**

Some have argued in the past that because the secondary education systems in many other countries are quite different from those in the United States, it is inappropriate to compare the performance of U.S. students with those in other countries. The fact that other countries differ in the decisions they have made about the nature of secondary education provides an opportunity to examine whether these differences in education systems are related to what students know at the end of their secondary schooling in mathematics and science. In addition, understanding something about the differences between education systems provides important information for interpreting the findings about student performance.

How Does Secondary Schooling In The Other TIMSS Countries Resemble And Differ From That In The United States?

Structure of Secondary Education

One major way in which the organization of schooling in the United States differs from that in many of the TIMSS countries is the amount of differentiation within secondary education. This differentiation can take at least two forms. One involves the **extent to which students are separated into different programs,** either within schools or between schools. The other is **whether the length of secondary schooling is the same for all students**—across all schools, programs, and regions of the country. **The United States is atypical among TIMSS countries in the lack of differentiation in secondary schooling on either dimension.**

The United States was one of five countries in TIMSS (the others are also former English colonies—Australia, Canada, New Zealand, and South Africa) where most students attend comprehen-

sive high schools, regardless of their ability, prior academic performance, and career goals (see Table A5.12 in Appendix 5). Within those comprehensive high schools, students select their courses each year. Although there are graduation requirements in terms of the number of courses students must complete in specified fields, students generally can enroll in any course for which they meet the prerequisites.

Most of the students in other TIMSS countries attend either specialized or mixed secondary schools. In specialized schools, students of different abilities or career goals attend separate types of schools. Although in some of these countries students have varying degrees of choice regarding their school type or program of study, once they enroll in a particular school or program, the specific courses they will take are generally fixed. In mixed secondary schools, students of different abilities or career goals all attend the same school, but based on ability or interest, students are divided into one of several pre-set programs of coursework within the school.

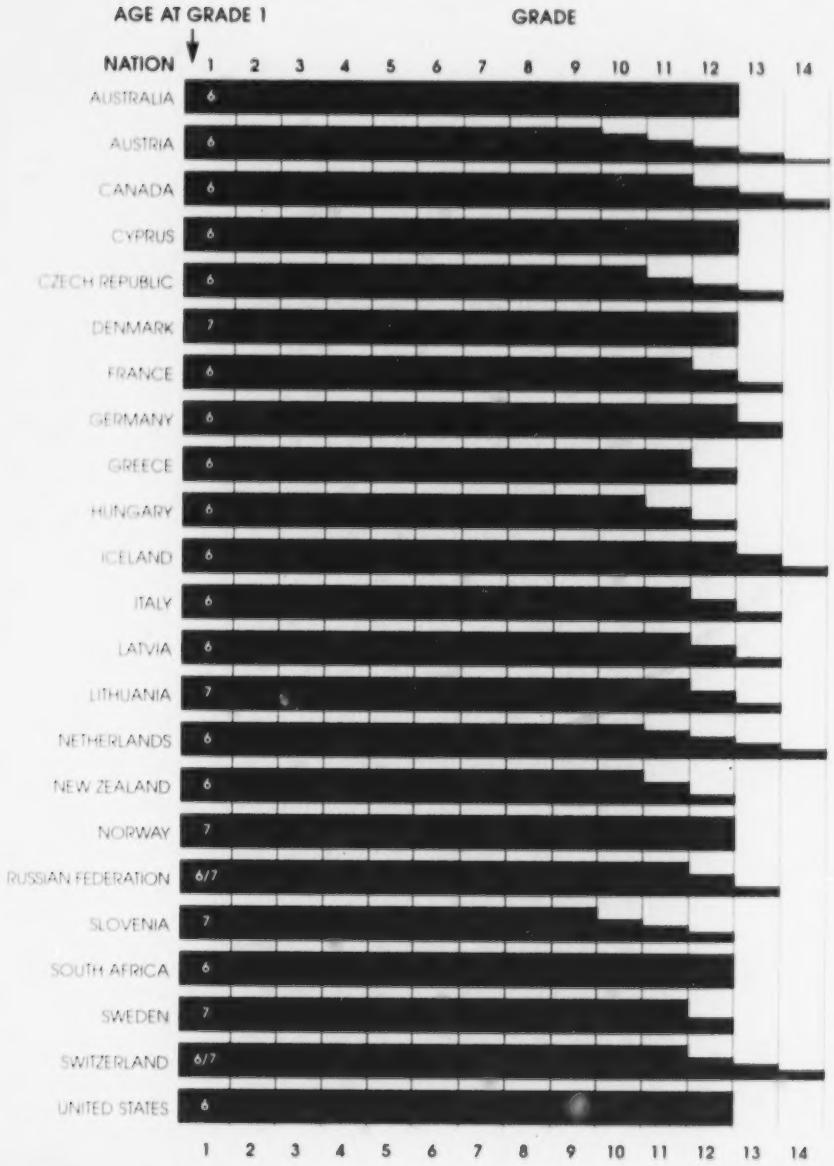
In 6 of the TIMSS countries, including the United States, secondary schooling ends at the same grade for all students. In the other 17 countries participating in some facet of TIMSS at this level, the length of schooling varies (Figure 22). Generally, vocationally-oriented programs involve fewer years of secondary schooling than do those with an academic focus. For example, in the Czech Republic, there are three types of secondary schools—*gymnasium* (academic), technical, and vocational—and depending on the school or program, students complete secondary schooling at the end of grades 10, 11, 12, or 13. Students in technical schools and *gymnasium* usually complete their secondary education at grade 12, but a few end at grade 13. In the vocational schools, the end of secondary education can occur between grades 10 and 13 depending on the type of vocation. In some countries, after completing one secondary vocational program, students may enroll in a second such program in another field.

In TIMSS, students were tested in the final year of secondary education regardless of their type of school or program, so that within the same country, students who took TIMSS varied in the number of years of schooling they had completed. Thus, in the Czech Republic, when TIMSS tested students in the final year of secondary school in each type of school, there were Czech students taking TIMSS who were in grades 10 to 13. **Across all 21 countries participating in the general knowledge portions of TIMSS, students as low as grade 10 and as high as grade 14 were tested** (Table A5.13 in Appendix 5). Like the United States, every country assessed students in grade 12 (except the Russian Federation where students complete general secondary school at grade 11), but in the majority of countries students in at least one other grade also participated in TIMSS.

Reflecting the differences in the structure and organization of the education systems in the various countries, **the average age of the students in each country taking the general knowledge assessments also varied across countries, from about 17 to 21** (Table A5.13 in Appendix 5). The average age of U.S. students was 18.1 years and the international average for all 21 countries in the general knowledge assessments was 18.7 years. Countries with relatively high average ages (19.0 or above) tended to be countries where primary school does not

FIGURE 22

AGE BEGINNING GRADE 1 AND GRADE(S) MARKING END OF SECONDARY SCHOOL IN TIMSS NATIONS



NOTE: The width of the bar segments do not indicate the proportion of the cohort that complete school at the end of the indicated grades.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School* Appendix A. Chestnut Hill, MA: Boston College.

start until age 7 and or where secondary schooling extends beyond grade 12. Most of these countries have much higher proportions of 18-year-olds enrolled in secondary school than the United States and some have one-fourth to one-third of 20-year-olds still enrolled in secondary school (compared to 2 percent of 20-year-olds in the United States). (See Table A5.14 in Appendix 5.)

Secondary Enrollment and Completion

One possible explanation for the poor performance of U.S. students might be that a much higher proportion of the U.S. population completes secondary education than in the countries that outperformed the U.S. on TIMSS. If that were the case, then the students participating in the TIMSS general knowledge assessments would represent an elite group within other countries while they would represent nearly all the population in the United States. However, data gathered as part of TIMSS and by the Organization for Economic Cooperation and Development (OECD) on secondary enrollment and completion indicate that this is not the case.

While in the past, it was true that the United States differed from many other countries in educating most of its young people through the end of secondary school, that was no longer true in the year TIMSS was conducted. **In the TIMSS countries as a whole, large proportions of the population now attend and complete secondary school** (Table A5.14 in Appendix 5). In 1995, enrollment in secondary education represented, on average, over 90 percent of children of secondary school age among all 21 countries participating in the general knowledge portion of TIMSS as well as in the United States.

While current secondary enrollment in the United States and the other TIMSS countries is similar, the United States still has an edge in secondary completions among a somewhat older age group, reflecting differences in secondary enrollment in past years. Data collected by OECD reveal that in 1995 the average proportion of the population ages 25-34 who had completed high school, while relatively high (78 percent) for the 14 TIMSS countries for which the information was available, was somewhat lower than in the United States (87 percent).[13]

Curriculum

Although the general knowledge assessments were not designed to match secondary mathematics and science curricula, the content of the U.S. secondary curriculum relative to the other TIMSS countries might contribute to the poor U.S. performance. A comparison of the topics covered in the mathematics and science general knowledge assessments with curriculum frameworks did reveal that **both general knowledge assessments covered content that is introduced later in the U.S. curriculum than it is introduced, on average, in the other TIMSS countries as a whole.**[14]

The content of the mathematics general knowledge assessment represented about a seventh-grade level of curriculum for most TIMSS nations, but was most equivalent to the ninth-grade curriculum in the United States. The science general knowledge content was most equivalent to ninth-grade curriculum internationally, and to eleventh-grade curriculum in the United States. The higher grade-level equivalent of the assessments in the United States reflects the relatively late appearance of algebra

and many geometry topics in mathematics, and of chemistry and physics in science in the U.S. curriculum compared to their appearance in the curriculum of other countries.

Another aspect of curriculum that differs among the TIMSS countries is the extent to which final approval about curriculum syllabi is centralized. **In about half of the TIMSS countries, decisions about curriculum syllabi are centralized at the national level.** That is, the national level of government has exclusive responsibility for or gives final approval of the syllabi for courses of study.

In a few countries, such curriculum decisions are regionally centralized, and in the remaining countries, including the United States, final approval of curriculum syllabi are not centralized (Table A5.15 in Appendix 5).

Support for Education

One factor that may be associated with both education system and student differences is the affluence of the countries, which may be translated into the level of resources available to schools and families. **The United States was one of the more affluent countries with a GNP per capita of $25,860 compared to $17,305 for all 21 countries participating in the general knowledge portion of TIMSS** (Table A5.16 in Appendix 5). However, about one-third of the countries had GNP per capita similar to or higher than the United States ($23,500 to $37,000). Similarly, the United States had higher per capita public spending on elementary/secondary education than two-thirds of the other countries. **It should be noted that the U.S. performance resembled, on average, the economically less-affluent countries (those with lower GNPs per capita and lower per capita expenditures on elementary/secondary education) participating in the general knowledge assessments, while two of the less affluent countries (Hungary and Slovenia) also outperformed the United States.**

We now turn our attention to the extent to which the United States is similar to or differs from the other TIMSS nations on factors related to the everyday lives of students both within and outside of school.

How Do U.S. Twelfth-Grade Students Compare Internationally On Factors Associated With Their Lives Inside And Outside Of School?

As discussed above, we know that upper secondary education, or "high school" as it is known in the United States, varies greatly among the TIMSS nations. Students in one country may attend a school with a particular focus based on their abilities or career goals, while students in another country may be required to choose among several specialties as their "major" in a general school. In other countries, students may create their own program by choosing among a variety of courses.

While we know much about the differences between school systems in the TIMSS nations, we know less about students' everyday lives in those schools, and, in particular, how aspects of their everyday lives may affect their performance. In order to learn more, TIMSS asked all students about a number of factors that are related to student performance within the United States and many other countries. For a few countries, information is not available for some of the factors.

Based on students' reports, TIMSS finds the following concerning those students who took the general knowledge assessments. (See Table A5.20 in Appendix 5 for a detailed summary of these results.)

Mathematics and Science Coursetaking

Countries may vary in how much mathematics and science students take in secondary school and at what level. Research has shown in the United States that more years of science and mathematics coursetaking in high school are associated with higher levels of performance.[35] If a similar pattern holds in other countries and greater proportions of students in high-achieving countries have studied mathematics and science for more years or have taken advanced courses than in the United States, that could contribute to the relatively poor performance of U.S. students.

Because of the differences in the ways the curriculum is delivered in the various countries, it is difficult to construct comparable measures for the amount or the level of mathematics and science that students in different countries have studied. Students were asked whether they were currently taking mathematics and science at the time they participated in TIMSS, which at least indicates whether they were still studying these subjects in their final year of secondary school. Countries did vary considerably in the proportion of students reporting they were currently taking mathematics (from about half to all students) and science (from one-third to all students).

U.S. graduating students were less likely to be taking mathematics or science than were their counterparts in other countries. While 66 percent of graduating students in the U.S. were currently taking mathematics, the average in all the countries participating in the general knowledge assessments was 79 percent. The same pattern was also true for science (53 percent for the United States and 67 percent for all the TIMSS countries).

Homework

One factor that could be related to U.S. students' performance is the amount of homework and studying they do. **U.S. students reported spending fewer hours on homework and studying per day than the international average for students in the final year of secondary school** (1.7 and 2.6 hours respectively). Students in 15 nations (out of 19) reported spending more hours, on average, studying or doing homework per day than their U.S. counterparts, while students in only one nation, the Czech Republic, reported a lower average number of hours studying or doing homework per day. (See table A5.20 in Appendix 5.)

Calculators and Computers

There is considerable discussion in the U.S. about how and to what extent calculators and computers should be incorporated into classroom instruction in mathematics and science. TIMSS asked students about their usage of calculators and computers in many settings—at home, school, and elsewhere. **U.S. students' use of calculators was similar to that of students in other countries.** About half of U.S. twelfth-grade students (52 percent) reported using a calculator on a daily basis, which is similar to the international average (55 percent).

In all nations, students were given the opportunity to use calculators if they wished to do so during the TIMSS mathematics and science general knowledge assessments. **While a majority of U.S. students reported taking advantage of the opportunity to use calculators during the mathematics and science general knowledge assessments, a smaller proportion of U.S. students did so than the international average** (71 and 79 percent, respectively). More students took advantage of the opportunity in 12 nations than did students in the United States.

About three-quarters of U.S. twelfth-grade students reported using a computer at school, home, or elsewhere, which is higher than the international average (73 and 57 percent, respectively).

Attitudes Toward Mathematics and Science

Perhaps U.S. students do less well because they have less positive attitudes toward mathematics and science. About 21 percent of U.S. twelfth graders said they liked mathematics a lot, which was higher than the international average of 15 percent.

Students were asked whether they liked biology, chemistry, earth science, and physics. For chemistry, earth science and physics, the percentage of U.S. students who said that they liked the subject or who liked it a lot (49, 68, and 47 percent respectively) was higher than the international average (42, 63, and 42 percent respectively). The percentage of U.S. students who said they liked biology or who liked biology a lot was 67, the same as the international average.

Personal Safety in School

The school environment should be conducive to learning. One factor that may detract from the amount of learning that takes place is a school environment where students' safety is somewhat problematic. **Students in TIMSS were asked about thefts and threats in school. The United States was above the international average in both.**

About one-quarter of U.S. twelfth-graders had experienced theft of their property at school in the month prior to the assessments, which was higher than the international average (Figure 23). Theft was experienced by a smaller percentage of students in 15 nations (out of 17).

While less common than theft in most nations around the world, approximately one-tenth of U.S. twelfth-grade students reported having been threatened at school in the month prior to TIMSS, which was higher than the international average (Figure 23). In only one other nation, South Africa, did a larger percentage of students report having been threatened than did students in the United States. Threats of violence at school were experienced by a smaller percentage of students in 10 nations (out of 16).

Television and Video Watching

The amount of television students watch is often mentioned as a factor related to achievement. **U.S. twelfth graders spent, on average, the same amount of time watching television or videos as the international average.** U.S. students watched an average of 1.7 hours of television or videos on a normal school day, which was the same amount of time as the average for the 20 countries for which data were available.

Working at a Paid Job

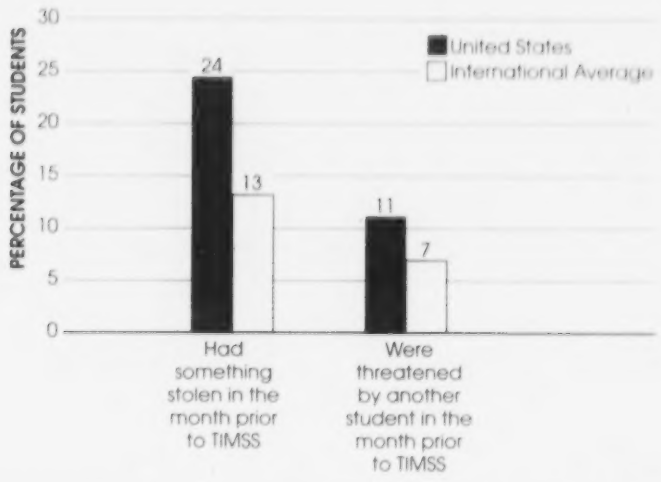
Students at the end of secondary school may spend their out-of-school time in a variety of ways other than studying and doing homework. If students work long hours, at part-time jobs, that may leave them with less time and energy to devote to school. **More U.S. twelfth-grade students reported that they worked at a paid job, and worked longer hours, on a normal school day, than did students in any other TIMSS nation** (Figure 24). A little more than half of U.S. students said that they worked 3 or more hours on a normal school day at a paid job compared with the international average of about one-fifth of all graduating students. Moreover, U.S. students reported that they worked an average of 3.1 hours on a normal school day, which was higher than for students in any other TIMSS nation.

Which Of These Factors Related To Education Systems And Students Are Associated With The Relatively Poor Performance Of U.S. Twelfth Graders In TIMSS On The General Knowledge Assessments?

Most of the factors described above do not seem to account for U.S. students' relatively poor performance. Among the factors related to the education systems, this is the case for differentiation

---

FIGURE 23:
U.S. Twelfth-Grade Students' Reports on Personal Safety at School in Comparison with the International Average



SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 4.2.1. Chestnut Hill, MA: Boston College.

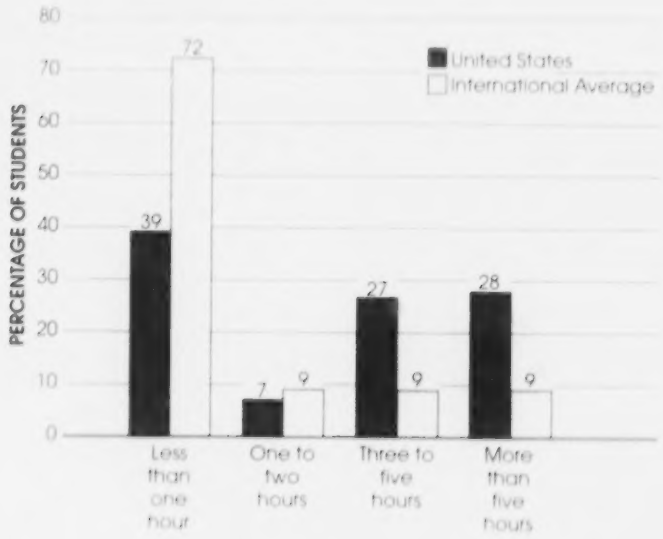
in the secondary education system, the grade level of the students participating in TIMSS, rates of secondary enrollment and completion, and centralization of decision-making about curriculum syllabi (Figures 25 and 26). **Only the average age of the students taking the general knowledge assessments and the curricular-level equivalent of those assessments seem to be possible factors contributing to the relatively poor U.S. performance on these assessments.**

While the average age of the students participating in TIMSS in the countries outperforming the United States ranged from 17.5 to 21.2 years, countries with an average age of 19.0 or above were somewhat more likely to outscore the United States than the countries in which the average age was less than 19.0.

The content of the general knowledge assessments represented material covered at a higher grade level in the United States than the other countries as a whole. However, estimates for the grade-level equivalents of the assessments for each of the other TIMSS countries individually are not currently available. **Therefore, we cannot currently compare how the assessments correspond to the curriculum in the countries that outperformed the United States to**

FIGURE 24:

U.S. Twelfth-Grade Students' Reports on Hours on a Normal School Day Spent Working at a Paid Job in Comparison with the International Average



SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 4.21. Chestnut Hill, MA: Boston College.

FIGURE 25:

Relationship Between U.S. Relative Performance and Schooling and Student Factors: Mathematics General Knowledge

FACTORS	U.S. COMPARED TO INTERNATIONAL AVERAGE OR MOST COMMON PATTERN ON THE FACTOR[1]	FACTOR ASSOCIATED WITH U.S. RELATIVE PERFORMANCE[2]	APPENDIX TABLE WITH SUPPORTING INFORMATION
MATHEMATICS GENERAL KNOWLEDGE			
DIFFERENTIATION IN SCHOOLS/PROGRAMS	LESS	NO	A5.12
DIFFERENTIATION IN LENGTH OF SECONDARY EDUCATION	LESS	NO	A5.12
AVERAGE AGE OF STUDENTS PARTICIPATING IN THE ASSESSMENT	BELOW	YES	A5.13
GRADE OF STUDENTS ASSESSED	SAME	NO	A5.13
CURRENT ENROLLMENT IN SECONDARY EDUCATION	SAME	NO	A5.14
SECONDARY COMPLETION AMONG 25-34 YEAR OLDS	ABOVE	NO	A5.14
CURRICULAR GRADE-LEVEL EQUIVALENT OF THE ASSESSMENT	ABOVE	—	NONE
CENTRALIZATION OF DECISION-MAKING ABOUT CURRICULUM SYLLABI	LESS	NO	A5.15
GNP PER CAPITA	ABOVE	NO	A5.16
PUBLIC EXPENDITURE ON ELEMENTARY/SECONDARY EDUCATION PER CAPITA	ABOVE	NO	A5.16
TAKING MATHEMATICS IN FINAL YEAR OF SECONDARY SCHOOL	BELOW	NO	A5.20
HOURS OF HOMEWORK	BELOW	NO	A5.20
DAILY USE OF CALCULATORS	SAME	NO	A5.20
CALCULATOR USE ON TIMSS	BELOW	YES	A5.20
USE OF COMPUTERS	ABOVE	NO	A5.20
POSITIVE ATTITUDES TOWARD MATHEMATICS	ABOVE	NO	A5.20
THEFT OF PROPERTY AT SCHOOL	ABOVE	NO	A5.20
PERSONAL THREATS AT SCHOOL	ABOVE	NO	A5.20
AVERAGE HOURS WATCHING TV OR VIDEOS	SAME	NO	A5.20
AVERAGE HOURS WORKING AT A PAID JOB ON A NORMAL SCHOOL DAY	ABOVE	NO	A5.20

— Data not available

1. Based on how the United States compares to the international average for the TIMSS countries for which data were available.
2. Based on whether the factor was associated with the relatively poor performance of the United States compared to the other participating countries.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Chestnut Hill, MA: Boston College; and Organisation for Economic Cooperation and Development. (1997). *Education at a Glance: OECD Indicators 1997.* Paris: OECD.

FIGURE 26:

Relationship Between U.S. Relative Performance and Schooling and Student Factors: Science General Knowledge

FACTORS	U.S. COMPARED TO INTERNATIONAL AVERAGE ON THE FACTOR[1]	FACTOR ASSOCIATED WITH U.S. RELATIVE PERFORMANCE[2]	APPENDIX TABLE WITH SUPPORTING INFORMATION
SCIENCE			
GENERAL KNOWLEDGE			
CURRICULAR GRADE-LEVEL EQUIVALENT OF THE ASSESSMENT	ABOVE	—	NONE
TAKING SCIENCE IN FINAL YEAR OF SECONDARY SCHOOL	BELOW	NO	A5.20
POSITIVE ATTITUDES TOWARD CHEMISTRY	ABOVE	NO	A5.20
POSITIVE ATTITUDES TOWARD EARTH SCIENCE	ABOVE	NO	A5.20
POSITIVE ATTITUDES TOWARD PHYSICS	ABOVE	NO	A5.20
POSITIVE ATTITUDES TOWARD BIOLOGY	SAME	NO	A5.20

— Data not available

1. Based on how the United States compares to the international average for the TIMSS countries for which data were available.
2. Based on whether the factor was associated with the relatively poor performance of the United States compared to the other participating countries.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Chestnut Hill, MA: Boston College.

how they correspond to the United States and the countries that performed similarly or worse than we did.

Most of the factors related to students' lives do not seem to account for U.S. students' relatively poor performance either. Among these factors, this is the case for mathematics and science coursetaking during the final year of secondary school, hours spent on homework or studying, the use of calculators, the use of computers, positive attitudes toward mathematics and science, personal safety in school, television and video watching, and hours spent working at a paid job. Only the percentage of students using a calculator during the TIMSS mathematics general knowledge assessment is related to the U.S. performance on the mathematics general knowledge assessment relative to the other TIMSS nations.

Countries in which a higher percentage of students used a calculator on the TIMSS mathematics general knowledge assessment were more likely to outperform the United States than countries with a similar or lower percentage of student calculator use on the mathematics general knowledge assessment. Eleven of the 12 countries with higher student calculator use during the TIMSS assessment than the United States performed better than the United States in mathematics general knowledge. Moreover, 5 of the 8 countries with similar or lower student calculator use during the assessment than the United States performed similar to or lower than the United States in mathematics general knowledge. However, it is unclear whether using a calculator helped students score higher on the TIMSS mathematics general knowledge assessment, or whether more able students were more likely to use a calculator on the assessment.

While most of the factors examined above do not appear to be associated with the relatively poor performance of the United States at twelfth grade in comparison with other nations, we now turn to the question of whether any of these same factors can explain the differences in the relative performance of U.S. students in TIMSS at eighth grade and at twelfth grade.

Why Do U.S. Students Perform More Poorly Relative To The International Average At The End Of Secondary Schooling Than In Eighth Grade?

The performance of all U.S. students was poorer in twelfth grade than in eighth grade relative to the other 19 countries which participated in TIMSS at both levels. **One factor that does seem to be associated with whether countries' relative position differed between the eighth grade and the end of secondary school general knowledge assessments is the average age of the students participating in the two assessments in each country** (Figure 27).

As indicated previously, there was considerable variation across the countries in the average age of students participating in the general knowledge assessments. This variation reflects two factors: the age at which students begin first grade (six in most countries, seven in a few) and the highest grade in secondary education (ranging from 10 to 14, depending on the country and the student's program). In countries where some of the students participating in the end of secondary school assessment

FIGURE 27:

Relationship Between U.S. Relative Performance and Education System Factors: Grade Eight and End of Secondary School

FACTORS	U.S. COMPARED TO INTERNATIONAL AVERAGE ON THE FACTOR[1]	FACTOR ASSOCIATED WITH DIFFERENCE IN RELATIVE PERFORMANCE IN EIGHTH GRADE AND END OF SCHOOL ASSESSMENTS[2]	APPENDIX TABLE WITH SUPPORTING INFORMATION
MATHEMATICS			
AGE OF STUDENTS IN END OF SECONDARY SCHOOL ASSESSMENT	BELOW	YES	A5.17
PROPORTION CURRENTLY TAKING MATHEMATICS AT END OF SECONDARY SCHOOL	BELOW	NO	A5.18
SCIENCE			
AGE OF STUDENTS IN END OF SECONDARY SCHOOL ASSESSMENT	BELOW	YES	A5.19
PROPORTION CURRENTLY TAKING SCIENCE AT END OF SECONDARY SCHOOL	BELOW	NO	A5.18

1. Based on how the United States compares to the international average for the TIMSS countries for which data were available.
2. Based on whether the factor was associated with the lower relative standing of the United States compared to the international average in twelfth grade than in eighth grade.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Chestnut Hill, MA: Boston College.

were in grades above 12, the average age tended to be older. As a result, the average age of students taking the end of secondary school assessment ranged from 16.9 to 21.2 years.

There was also variation, though less so, in the average age of students participating in the middle school assessment. The targeted population in that assessment was the two grades with the largest number of 13-year olds at the beginning of the school year. In most countries, the grades were seven and eight, but in a few countries—generally those in which first grade begins at age seven—the grades assessed were six and seven. The "eighth grade" comparisons were based on eighth graders for the former countries and seventh graders for the latter. Although the ages were generally comparable across countries, the average age for each country was affected by factors such as the exact timing of the assessment and the variation in age within grades. The country averages for students in the eighth grade comparisons ranged from 13.6 to 15.4 years.

In the countries whose standing relative to the international average was more favorable at the end of secondary schooling than in eighth grade, the average age of the students participating in TIMSS tended to be younger than the international average in the "eighth grade" assessment and older than the international average in the end of school assessment. In addition, **in those countries whose relative position was less favorable in the end of school assessment than it was in the eighth grade assessment, the average age of the students participating in the end of school assessment tended to be below the average, which was the case for the United States.**

As a result of these patterns, the difference between the average age of the students participating in the two assessments was greater for countries whose relative standing was more favorable at the end of secondary schooling than for countries whose relative standing was less favorable at the end of secondary schooling than in eighth grade. On average, the difference in age of the students participating in the two assessments was about 5 years 3 months in countries whose relative standing was more favorable at the end of secondary schooling and 3 years 6 months in countries with a less-favorable standing at the end of secondary school (Tables A5.17 and A5.19 in Appendix 5).

Countries where more students were taking mathematics in their final year of secondary school were not more likely to have a higher relative standing in twelfth grade compared to their standing in eighth grade. In fact, for mathematics, countries whose relative standing was less favorable in twelfth grade had a higher proportion of students enrolled in mathematics in the final year of secondary schooling, on average, than did those whose relative standing was higher in twelfth grade, although this pattern did not hold for the United States. The United States was the only country whose relative standing was lower in twelfth grade where the proportion of students currently taking mathematics was below the international average.

We now turn our attention to examining the context in which advanced mathematics and physics students learn.

THE CONTEXT OF LEARNING FOR ADVANCED MATHEMATICS AND SCIENCE STUDENTS IN THE FINAL YEAR OF SECONDARY SCHOOL

Decisions made by nations in how they structure and provide secondary education affect all students, including advanced mathematics and science students. This section examines how differences in the delivery and implementation of advanced mathematics and science courses among the TIMSS nations relate to the performance of advanced mathematics and science students. In particular, this section will focus on advanced science and mathematics students' everyday experiences in school and the classroom to learn more about how aspects of their school lives may be related to performance in physics and advanced mathematics.

How Do U.S. Physics and Advanced Mathematics Students Compare Internationally on Factors Associated With Their Lives In School?

Unlike a number of their U.S. peers, most advanced mathematics and advanced science students continue to take mathematics or science courses in their final year of secondary school. To take advantage of this fact, TIMSS asked physics and advanced mathematics students for information about their classroom experiences in those subjects.

Results from TIMSS indicate the following information about students who took the physics and advanced mathematics assessments. (See Tables A5.21 and A5.22 in Appendix 5 for detailed summary information.)

Homework

Students enrolled in mathematics and in physics in the last year of secondary school were asked how frequently they were assigned homework in these subjects. U.S. twelfth-grade physics and advanced mathematics students more frequently reported being assigned homework three or more times per week than the international average. Half of U.S. twelfth-grade physics students (51 percent) reported being assigned physics homework three or more times a week compared to the international average of forty percent for advanced science students. Among advanced mathematics students, 90 percent of U.S. students reported this much homework in mathematics, while the international average was 65 percent.

Calculators

A higher percentage of U.S. physics and advanced mathematics students reported using a calculator on a daily basis than their international counterparts. Approximately 80 percent of both U.S. advanced mathematics and physics students reported using a calculator on a daily basis. The international average for both subjects was about 70 percent. As with the mathematics and science general knowledge assessments, students in all TIMSS nations were provided the opportunity to use calculators during the physics and advanced mathematics assessments. **More U.S. students who took the advanced mathematics assessment reported using a calculator during the assessment (86 percent) than the international average (76 percent). Among U.S. students who took the physics assessment, 81 percent of students reported using a calculator during the assessment, similar to the international average (79 percent).**

Hours of Instruction

TIMSS asked physics and advanced mathematics students to report on the number of hours of mathematics or physics instruction they received each week. **Among U.S. twelfth-grade advanced mathematics students who were currently taking a mathematics course, a much lower percentage reported receiving five or more hours of mathematics instruction per week than the international average.** Twelve percent of U.S. advanced mathematics students stated that they received five or more hours of mathematics instruction per week, compared to an international average of 39 percent.

In physics, the pattern was the reverse. **A higher percentage of U.S. twelfth-grade physics students currently taking physics reported receiving five or more hours of physics instruction per week than the international average.** Seventeen percent of U.S. physics students stated that they received five or more hours of physics instruction per week; the international average was 8 percent.

Computers

TIMSS queried students in advanced mathematics or physics courses about using computers to solve exercises or problems in their lessons. **U.S. students were more likely to report using a computer in these subjects than the international average.** Thirty-four percent of U.S. advanced mathematics and 42 percent of U.S. physics students reported being asked to use a computer to solve exercises or problems during at least some lessons, which is higher than the international average for both groups, 28 percent and 29 percent respectively.

Reasoning Tasks

Among the many aspects of classroom instruction that experts have targeted for improvement is providing opportunities for students to develop and improve their reasoning skills. To obtain a measure of how often students are asked to do reasoning tasks in class, TIMSS queried students whether they have been asked by their teachers to do any of the following: explain their reasoning behind an idea; represent and analyze relationships using tables, charts, or graphs; work on problems for which there is no immediately obvious method or solution; or write equations to represent relationships. Based on the responses to these questions, **U.S. students in both subjects were more likely to report being asked to do reasoning tasks than the international average.** Forty-three percent of U.S. twelfth-grade advanced mathematics students reported that they were asked to do at least one of these reasoning tasks in "every mathematics lesson," while the international average was 32 percent. Among U.S. physics students, 36 percent reported that they were asked to do at least one of these reasoning tasks in "every physics lesson," compared to the international average of approximately 23 percent.

Laboratory Experiments

Another area of education that has received much attention is the use of experiments to enhance students' learning of concepts and knowledge in science. **When queried whether they were asked to conduct laboratory experiments during physics lessons, 96 percent of U.S. physics students replied affirmatively, which was higher than the international average (79 percent) of advanced science students who replied similarly.** More U.S. physics students stated that they were asked to conduct laboratory experiments than students in 10 of the 15 other TIMSS nations that participated in the physics assessment.

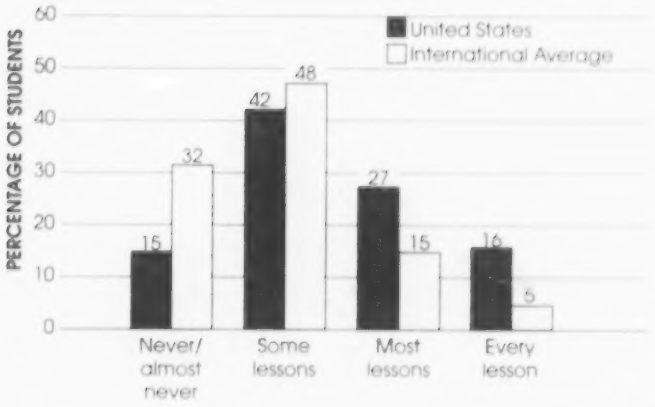
Connecting Mathematics to Everyday Problems

Some experts believe that one way to improve students' interest in mathematics is to connect it to everyday, real-world problems rather than just to abstract concepts. **U.S. advanced mathematics students were more likely to report that they were asked to connect mathematics to everyday problems, than the international average** (85 and 68 percent respectively) (Figure 28). More U.S. advanced mathematics students reported that they were asked to apply mathematics to everyday problems in their mathematics lessons than students in 13 of the 15 other nations that participated in the advanced mathematics assessment.

Are Any Of These Instructional Experiences Of Physics And Advanced Mathematics Students Associated With U.S. Relative Performance?

There does not appear to be a relationship between student performance in physics or advanced mathematics and most other instructional factors related to advanced mathematics and physics (see Figure 29 and Tables A5.21 and A5.22 in Appendix 5). Only the percentage of advanced mathematics students who received five hours or more of mathematics instruction per week was related to the U.S. performance relative to the other participating countries.

FIGURE 28:
ADVANCED MATHEMATICS STUDENTS' REPORTS ON CONNECTING MATHEMATICS TO EVERYDAY PROBLEMS



SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 7.4. Chestnut Hill, MA: Boston College.

FIGURE 29:

Relationship Between U.S. Relative Performance and Instructional Factors: Physics and Advanced Mathematics Students

FACTORS	U.S. COMPARED TO INTERNATIONAL AVERAGE ON THE FACTOR[1]	FACTOR ASSOCIATED WITH U.S. RELATIVE PERFORMANCE[2]	APPENDIX TABLE WITH SUPPORTING INFORMATION
ADVANCED MATHEMATICS			
HOMEWORK ASSIGNMENTS	ABOVE	NO	A5.21
DAILY USE OF CALCULATOR	ABOVE	NO	A5.21
CALCULATOR USE ON TIMSS	ABOVE	NO	A5.21
HOURS OF INSTRUCTION	BELOW	YES	A5.21
USE OF COMPUTER IN LESSONS	ABOVE	NO	A5.21
ASKED TO DO REASONING TASKS IN LESSONS	ABOVE	NO	A5.21
CONNECT MATHEMATICS TO EVERYDAY PROBLEMS IN LESSONS	ABOVE	NO	A5.21
PHYSICS			
HOMEWORK ASSIGNMENTS	ABOVE	NO	A5.22
DAILY USE OF CALCULATOR	ABOVE	NO	A5.22
CALCULATOR USE ON TIMSS	SAME	NO	A5.22
HOURS OF INSTRUCTION	ABOVE	NO	A5.22
USE OF COMPUTER IN LESSONS	ABOVE	NO	A5.22
ASKED TO DO REASONING TASKS IN LESSONS	ABOVE	NO	A5.22
LABORATORY EXPERIMENTS IN LESSONS	ABOVE	NO	A5.22

1. Based on how the United States compares to the international average for the TIMSS countries participating in the assessment.
2. Based on whether the factor was associated with the relatively poor performance of the United States on the assessment compared to the other participating countries.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Chestnut Hill, MA: Boston College.

Countries in which a higher percentage of advanced mathematics students received five or more hours of mathematics instruction per week were more likely to outperform the U.S. than countries with a similar or lower percentage of students receiving that amount of instruction. All seven countries in which a higher proportion of advanced mathematics students received five or more hours of mathematics instruction per week outperformed the United States on the advanced mathematics assessment. Of the seven countries in which the advanced mathematics students were no more likely than U.S. students to receive five or more hours of mathematics instruction per week, three performed similar to and four outperformed the United States.

A similar pattern was not found for the amount of physics instruction that advanced science students received per week. However, it should be noted that students were asked about the amount of instruction they received in physics, not in all science courses that they were taking. In many of the TIMSS countries, a substantial proportion of students take more than one science course in the final year of secondary school.[9]

DISCUSSION

We have examined the early evidence from TIMSS and other sources comparing the United States to the international average of TIMSS countries on various factors that many experts believe are related to educational performance. When appropriate, we have examined whether these differences are associated with the relatively low performance of the United States in the TIMSS mathematics and science general knowledge, advanced mathematics, and physics assessments. **Initial evidence does not point definitively to any factor, or group of factors, that would explain U.S. students' performance in comparison with their international peers.**

We did note, however, that two factors—the average age of students at the time of the assessment and the percentage of students who reported using a calculator during the assessment—were associated with U.S. students' general knowledge of mathematics compared to students in other countries. Also, one factor—the percentage of students who received at least five hours of mathematics instruction per week—was associated with the relative performance of the students in advanced mathematics.

In addition, one factor that appears to be associated with differences in countries' relative position between eighth grade and the end of secondary school is the average age of the students participating in the two assessments in each country.

Further analyses may reveal underlying patterns that are not apparent in these initial results. For example, while the factors we have examined may not explain our performance relative to most of the countries that outperformed us, some could be influential relative to at least one of the countries. Furthermore, many of these factors are inter-related and this analysis looked at each factor separately.

It is important to note that while most of the student characteristics that we examined did not explain U.S. performance relative to other countries, many were related to individual student performance within the United States and other countries. For example, although country averages for television watching, homework, and mathematics and science course-taking were not related to average performance, individual students who watched less television, did more homework, and took mathematics and science during the final year of secondary school generally outperformed their peers.[17] While this may seem counter-intuitive, it can arise when there are country-level factors that influence performance for all students in a similar manner. Additional analyses are needed to understand more fully the interrelationships among individual and country-level factors.

CONCLUSIONS

This report has presented highlights from the initial analyses of the academic performance of the U.S. twelfth graders in comparison with performance of students from other countries at the end of secondary education. The performance of U. S. students in mathematics and science at the end of secondary school is among the lowest of those countries participating in TIMSS. This is true for all students as well as for students in advanced mathematics and in physics.

The report has also presented the evidence available from early analyses concerning why U.S. students' performance is one of the lowest among the participating TIMSS countries. TIMSS does not suggest any single factor or combination of factors that can explain why our performance is so low. From our initial analyses, it also appears that some factors commonly thought to influence individual student performance are not strongly related to performance when comparing average student performance across countries.

TIMSS provides a rich source of information about student performance in mathematics and science and about education in other countries. These initial findings suggest that to use the study most effectively, we need to pursue the data beyond this initial report, taking the opportunity and time to look at interrelationships among factors in greater depth.

WORKS CITED

1. National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: National Council of Teachers of Mathematics.

2. National Council of Teachers of Mathematics. (1991). *Professional Standards for Teaching Mathematics.* Reston, VA: National Council of Teachers of Mathematics.

3. American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy.* New York: Oxford Press.

4. National Academy of Sciences. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

5. Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Chestnut Hill, MA: Boston College.

6. Elley, W.B. (1992). *How in the World Do Students Read?* The Hague, Netherlands: International Association for the Evaluation of Educational Achievement.

7. Pelgrum, H. and Plomp, T. (1993). *International IEA Computers in Education Study.* New York: Pergamon Press.

8. U.S. Department of Education, National Center for Education Statistics. (1996). *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context.* NCES 97-198. Washington, DC: National Center for Education Statistics.

9. U.S. Department of Education, National Center for Education Statistics. (1997). *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context.* NCES 97-255. Washington, DC: National Center for Education Statistics.

10. Martin, M. and Kelly, D. (1996). *Third International Mathematics and Science Study: Technical Report, Volume I: Design and Development.* Chestnut Hill, MA: Boston College; and Martin, M. and Mullis, I.V.S. (1996). *Third International Mathematics and Science Study: Quality Assurance in Data Collection.* Chestnut Hill, MA: Boston College.

11. Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Chestnut Hill, MA: Boston College.

12. Carey, N., Farris, E., and Carpenter, J. (1994). *Curricular Differentiation in Public High Schools.* NCES 95-360. Washington, DC: National Center for Education Statistics.

13. Organisation for Economic Cooperation and Development. (1997). *Education at a Glance: OECD Indicators 1997.* Paris: OECD.

14. Schmidt, W. (forthcoming). *Facing the Consequences: Using TIMSS for a Closer Look at United States Mathematics and Science Education.* Hingham, MA: Kluwer.

15. Madigan, T. (1997). *Science Proficiency and Course Taking in High School.* NCES 97-838. Washington, DC: National Center for Education Statistics; Rock, D., and Pollack, J. (1995). *Mathematics Course-Taking and Gains in Mathematics Achievement.* NCES 95-714. Washington, DC: National Center for Education Statistics; Owings, J.A. and Lee, R. (1994). *Changes in Math Proficiency between 8th and 10th Grade.* NCES 93-455. Washington, DC: National Center for Education Statistics; and Hoffer, T.B., Radinski, K.A., and Moore, W. (1995). *Social Background Differences in High School Mathematics and Science Coursetaking and Achievement.* NCES 95-206. Washington, DC: National Center for Education Statistics.

16. Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Chestnut Hill, MA: Boston College.

17. Ibid. (1998).

APPENDICES

APPENDIX 1
SUMMARY OF INTERNATIONAL STUDY GUIDELINES AND DEFINITION OF ELIGIBLE STUDENTS

Twenty-three nations participated in the study. Twenty-one participated in the general assessments, while two other nations (Greece and Latvia) only participated in one or both of the advanced assessments.

To identify comparable groups across countries for the three assessments, TIMSS countries were asked to identify eligible students in terms of common definitions, after adapting the definitions to country-specific situations. Students in the mathematics and science general knowledge assessments were to be in their final year of secondary school. For the advanced mathematics assessment, eligible students were those who had taken or were taking advanced courses in mathematics. For the physics assessment, students were those who had taken or were taking physics.

The international guidelines specified the following sampling standards:

- the sample was to be representative of at least 90 percent of students in the total population eligible for the study. Therefore, exclusion rates must be under 10 percent.
- the school participation rate without the use of replacement schools must be at least 50 percent, **and**
- the combined participation rate (the product of school and student participation rates after replacements) must be at least 75 percent, or school and student participation rates must each be 85 percent.
- Countries were also required to submit a sampling plan for approval by the TIMSS International Study Center.

Most of the TIMSS countries experienced some deviation from international guidelines for execution of the study, at the end of secondary school, in one or more of the assessments. All deviations from these guidelines are **bolded** in the tables in Appendix 1.

TABLE A1.1

Nations' Definitions of Eligible Students and Whether Met Sampling Standards: Mathematics and Science General Knowledge Assessments

Nation	Population and exclusion rate	Whether met sampling standards
(AUSTRALIA)	Students in the final year of secondary school, Grade 12, in government, Catholic, and independent schools. Exclusion rate: 6%	**School participation rate before replacement: 49%, Combined participation rate: 52%**
(AUSTRIA)	Students in their final year of academic schools (Grade 12), their final year of higher technical and vocational school (Grade 13), their final year of medium technical and vocational school (Grades 10, 11, or 12 depending on the vocational program of the student), and students in their final year of apprenticeship (Grades 12, 13, or 14). **Exclusion rate: 18%** (students enrolled in teacher training colleges and courses lasting less than three years excluded)	**School participation rate before replacement: 36%, Combined participation rate: 73%**
(CANADA)	Students in Grade 12 in all provinces except in Grades 13 and 14 (depending on program) in Quebec; in Ontario, also students completing the Ontario Academic Credits (OAC) in Grade 13. Exclusion rate: 9%	School participation rate before replacement: 82%. **Combined participation rate: 68%**
(CYPRUS)	Students in Grade 12 of *lycea* and the technical schools. Vocational students in technical schools were not tested. Students in the private vocational schools were not included. **Exclusion rate: 22%** (private and vocational schools excluded)	School participation rate before replacement: 100%. Combined participation rate: 98%
CZECH REPUBLIC	Students in their final year of each type of school. In technical schools and *gymnasia*, students in Grades 12 and 13 were tested. In vocational schools students in Grades 10, 11, 12 and 13 were tested, depending on their vocation. Exclusion rate: 6%	School participation rate before replacement: 100%. Combined participation rate: 92%

TABLE A1.1 (CONTINUED)

MATHEMATICS AND SCIENCE GENERAL KNOWLEDGE ASSESSMENTS

Nation	Population and exclusion rate	Whether met sampling standards
(DENMARK)	Students in Grade 12 of the general secondary and vocational schools were tested; however, students finishing their formal schooling after *Folkeskole* (Grade 9) were not tested. Exclusion rate: 2%	**Did not follow sampling procedures** School participation rate before replacement: 55% **Combined participation rate: 49%**
(FRANCE)	Students in their final year of preparation for all types of the *baccalauréat* which includes students in Grade 12 or Grade 13 (depending on the type of exam). Also tested were students in the final year of preparation for the *Brevet d'études professionnelles* or the *Certificat d'aptitude professionnelle* who will not continue towards a *baccalauréat* (Grade 11). Exclusion rate: 1%	School participation rate before replacement: 80% **Combined participation rate: 69%**
(GERMANY)	Students in their final year in the *gymnasium* and the vocational education programs. This corresponded to Grade 13 in the Laender of the former West Germany and to Grade 12 in the Laender of the former East Germany. **Exclusion rate: 11%**	**Did not follow sampling procedures** School participation rate before replacement: 89% Combined participation rate: 80%
HUNGARY	Students in their final year of academic secondary and vocational schools (Grade 12) and students in the final in-school year of trade school (Grade 10). Exclusion rate: 0%	School participation rate before replacement: 100% Combined participation rate: 98%
(ICELAND)	Students who were to graduate that year from an upper secondary school, that is, students in Grades 12, 13, and 14. Exclusion rate: 0%	School participation rate before replacement: 100% **Combined participation rate: 74%**

TABLE A1.1 (CONTINUED)
MATHEMATICS AND SCIENCE GENERAL KNOWLEDGE ASSESSMENTS

Nation	Population and exclusion rate	Whether met sampling standards
(ITALY)	Students in all types of schools in their final year of secondary school. The final grade of school depended on their focus of study within the school type, ranging from Grade 11 to Grade 13. Students in private schools were not tested. **Exclusion rate: 30%** (four regions of 20 were excluded).	School participation rate before replacement: 60% **Combined participation rate: 62%**
(LITHUANIA)	Students in final year, Grade 12 in vocational, *gymnasia*, and secondary schools where Lithuanian is the language of instruction. Schools not under the authority of the Ministry of Education or the Ministry of Science were excluded. **Exclusion rate: 16%** (schools where Lithuanian was not the language of instruction).	School participation rate before replacement: 97% Combined participation rate: 85%
(NETHERLANDS)	Students in final year, Grade 12 of 6-year pre-university program; students in final year, Grade 11, in 5-year senior general secondary program; and students in the second year, Grade 12, of a two to four year senior secondary vocational program. Students in apprenticeship programs were not tested. **Exclusion rate: 22%** (short senior vocational and apprenticeship programs excluded).	**Did not follow sampling procedures** **School participation rate before replacement: 36%** **Combined participation rate: 49%**
NEW ZEALAND	Students in Grade 12 and students in Grade 11 who were not returning to school for Grade 12. Exclusion rate: 0%	School participation rate before replacement: 87% Combined participation rate 81%
(NORWAY)	Students in Grade 12 in all areas of study. Exclusion rate: 4%	School participation rate before replacement: 74% **Combined participation rate: 71%**
(RUSSIAN FEDERATION)	Students in final year, Grade 11, of general secondary school. Students in vocational programs were not tested. **Exclusion rate: 43%** (vocational schools and non-Russian speaking students excluded).	School participation rate before replacement: 93% Combined participation rate: 90%

TABLE A1.1 (CONTINUED)

MATHEMATICS AND SCIENCE GENERAL KNOWLEDGE ASSESSMENTS

Nation	Population and exclusion rate	Whether met sampling standards
(SLOVENIA)	Students in Grade 12 in *gymnasia* and in technical secondary schools, and students in Grade 11 in vocational schools. Students finishing vocational school in Grades 9 and 10 were not tested. Exclusion rate: 6%	**Did not follow sampling procedures** **School participation rate before replacement: 46%** **Combined participation rate: 42%**
(SOUTH AFRICA)	Students in Grade 12. Exclusion rate: 0%	**Did not follow sampling procedures** School participation rate before replacement: 65% **Combined participation rate: 65%**
SWEDEN	Students in Grade 12 in schools with the new three-year upper-secondary school system, and in the former two- or three-year system, students in the final year, Grade 11 or 12, respectively. Exclusion rate: 0%	School participation rate before replacement: 95% Combined participation rate: 82%
SWITZERLAND	Students in their final year of *gymnasium*, general education, teacher training, and vocational training. This corresponded to Grade 11 or 12 in *gymnasium* (final year depending on canton), Grade 12 in the general track, Grade 12 in the teacher-training track, and Grade 11, 12, or 13 in the vocational track (final year varies by occupation). Exclusion rate: 3%	School participation rate before replacement: 87% Combined participation rate: 85%
(UNITED STATES)	Students in Grade 12. Exclusion rate: 4%	School participation rate before replacement: 77% **Combined participation rate: 64%**

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. Specific deviations from these guidelines are bolded.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Appendix A, Tables B.4 and B.10, and Figure B.4. Chestnut Hill, MA: Boston College.

89

TABLE A1.2

Nations' Definitions of Eligible Students and Whether Met Sampling Standards: Advanced Mathematics Assessment

Nation	Population and exclusion rate*	Whether met sampling standards
(AUSTRALIA)	Students in their final year of senior secondary, Grade 12, enrolled in mathematics courses (varies across states) preparing them for post-secondary study, and students in Grade 12 who took such mathematics courses during Grade 11. Exclusion rate: 6%	**School participation rate before replacement: 47%** **Combined participation rate: 55%**
(AUSTRIA)	Students in their final year of the academic (Grade 12) or higher technical (Grade 13) track, taking courses in advanced mathematics. **Exclusion rate: 18%** (students enrolled in teacher training colleges and courses lasting less than three years excluded)	**School participation rate before replacement: 37%** Combined participation rate: 81%
CANADA	Students in their final year in mathematics courses preparing them for postsecondary study, Grade 12 or 13 (varies by province), except in Quebec where students in the two-year science program were tested. Exclusion rate: 9%	School participation rate before replacement: 85% Combined participation rate: 77%
(CYPRUS)	Students in their final year (Grade 12) in the mathematics/science program of study at the *lyceum*. **Exclusion rate: 22%** (private and vocational schools excluded)	School participation rate before replacement: 100% Combined participation rate: 96%
CZECH REPUBLIC	*Gymnasium* students in their final year of study, Grade 12 or 13. Exclusion rate: 6%	School participation rate before replacement: 100% Combined participation rate: 92%
(DENMARK)	Mathematics and physics students in the *gymnasium* and mathematics students in their final year, Grade 12, of the technical or higher preparation tracks. Exclusion rate: 2%	**Did not follow sampling procedures** School participation rate before replacement: 55% **Combined participation rate: 49%**

TABLE A1.2 (CONTINUED)
ADVANCED MATHEMATICS ASSESSMENT

Nation	Population and exclusion rate*	Whether met sampling standards
FRANCE	Students in their final year of the scientific track, Grade 12, preparing the *baccalauréat général*. Exclusion rate: 1%	School participation rate before replacement: 90% Combined participation rate: 77%
(GERMANY)	Students in their final year, Grade 12 or 13 depending on the Laender, in advanced mathematics courses (three to five periods per week) **Exclusion rate: 11%**	School participation rate before replacement: 79% Combined participation rate: 78%
GREECE	Students in their final year, Grade 12, of the general (academic) *Lyceum* and of the multi-branch *Lyceum*, taking advanced courses in mathematics and/or science in preparation for university disciplines requiring mathematics. Exclusion rate: 0%	School participation rate before replacement: 76% Combined participation rate: 87%
(ITALY)	Students in their final year of *Liceo Scientifico* (classical schools), Grade 11, 12, or 13, depending on the program of study, and *Instituti Technici* (technical schools), Grade 13. **Exclusion rate: 30%** (four regions of 20 were excluded).	School participation rate before replacement: 70% **Combined participation rate: 68%**
(LITHUANIA)	Students in their final year, Grade 12, of the mathematics and science *gymnasia* and students in secondary schools offering enhanced curriculum in mathematics. **Exclusion rate: 16%** (schools where Lithuanian was not the language of instruction).	School participation rate before replacement: 100% Combined participation rate: 92%
(RUSSIAN FEDERATION)	Students in their final year, Grade 11, in general secondary schools in advanced mathematics courses or advanced mathematics and physics courses. **Exclusion rate: 43%** (vocational schools and non-Russian speaking students excluded).	School participation rate before replacement: 98% Combined participation rate: 96%

TABLE A1.2 (CONTINUED)
ADVANCED MATHEMATICS ASSESSMENT

Nation	Population and exclusion rate*	Whether met sampling standards
(SLOVENIA)	Students in their final year of *gymnasium* and technical and professional schools. Grade 12, all of whom were taking advanced mathematics courses. Exclusion rate: 6%	**Did not follow sampling procedures** **School participation rate before replacement: 46%** **Combined participation rate: 42%**
SWEDEN	Students in their final year, Grade 12, of the Natural Science or Technology lines. Exclusion rate: 0%	School participation rate before replacement: 95% Combined participation rate: 89%
SWITZERLAND	Students in their final year, Grade 12 or 13, of the scientific track of the *Maturitätsschule* (gymnasium) in schools and programs (A-E) with federal recognition. Exclusion rate: 3%	School participation rate before replacement: 99% Combined participation rate: 87%
(UNITED STATES)	Students in Grade 12 who had taken or were taking Advanced Placement calculus, calculus, or pre-calculus. Exclusion rate: 4%	School participation rate before replacement: 76% **Combined participation rate: 67%**

* Sample exclusion rates are based on all students in the final year of secondary school, not just those eligible to participate in the advanced mathematics assessment.

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. Specific deviations from these guidelines are bolded.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Appendix A, Tables B.4 and B.11, and Figure B.5. Chestnut Hill, MA: Boston College.

TABLE A1.3

Nations' Definitions of Eligible Students and Whether Met Sampling Standards: Physics Assessment

Nation	Population and exclusion rate*	Whether met sampling standards
(AUSTRALIA)	Students in the final year of secondary school, Grade 12, enrolled in Year 12 physics. Exclusion rate: 6%	School participation rate before replacement: 63% **Combined participation rate: 54%**
(AUSTRIA)	Students in their final year of the academic (Grade 12) or higher technical (Grade 13) track, taking courses in physics. **Exclusion rate: 18%** (Students enrolled in teacher training colleges and courses lasting less than three years excluded).	**School participation rate before replacement: 37%** Combined participation rate 81%
(CANADA)	Students in their final year in physics courses preparing them for post-secondary study, Grade 12 or 13 (varies by province), except in Quebec where students in the two-year science program were tested. Exclusion rate: 9%	School participation rate before replacement: 80% **Combined participation rate: 73%**
(CYPRUS)	Students in their final year (Grade 12) of the mathematics/science program of study at the *lyceum*. **Exclusion rate: 22%** (private and vocational schools excluded).	School participation rate before replacement: 100% Combined participation rate 96%
CZECH REPUBLIC	*Gymnasium* students in their final year of study, Grade 12 or 13. Exclusion rate: 6%	School participation rate before replacement: 100% Combined participation rate 92%
(DENMARK)	Mathematics and physics students in the *gymnasium* and physics students in their final year, Grade 12, of the technical track. Exclusion rate: 2%	**Did not follow sampling procedures** School participation rate before replacement: 55% **Combined participation rate: 47%**

TABLE A1.3 (CONTINUED)
PHYSICS ASSESSMENT

Nation	Population and exclusion rate*	Whether met sampling standards
FRANCE	Students in their final year of the scientific track, Grade 12, preparing for the *baccalauréat général*. Exclusion rate: 1%	School participation rate before replacement: 90% Combined participation rate: 77%
(GERMANY)	Students in the final year, Grade 12 or 13 depending on the Laender, in physics courses (3 to 5 periods per week). **Exclusion rate: 11%**	School participation rate before replacement: 77% Combined participation rate: 82%
GREECE	Students in their final year, Grade 12, of the general (academic) *Lyceum* and the multi-branch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring physics. Exclusion rate: 0%	School participation rate before replacement: 76% Combined participation rate: 87%
(LATVIA)	Students in Grade 12, enrolled in advanced physics courses, in Latvian-speaking academic secondary schools. **Exclusion rate: 50%** (non-Latvian-speaking academic secondary schools).	School participation rate before replacement: 84% Combined participation rate: 77%
NORWAY	Students in their final year, Grade 12, of the three-year physics course in the general academic branch. Exclusion rate: 4%	School participation rate before replacement: 78% Combined participation rate: 83%
(RUSSIAN FEDERATION)	Students in their final year, Grade 11, in general secondary schools in advanced physics courses or advanced mathematics and physics courses. **Exclusion rate: 43%** (vocational schools and non-Russian-speaking students excluded).	School participation rate before replacement: 98% Combined participation rate: 95%
(SLOVENIA)	Students in their final year of *gymnasia*, Grade 12, taking the physics *matura* examination. Exclusion rate: 6%	**Did not follow sampling procedures** **School participation rate before replacement: 46%** **Combined participation rate: 43%**

TABLE A1.3 (CONTINUED)
PHYSICS ASSESSMENT

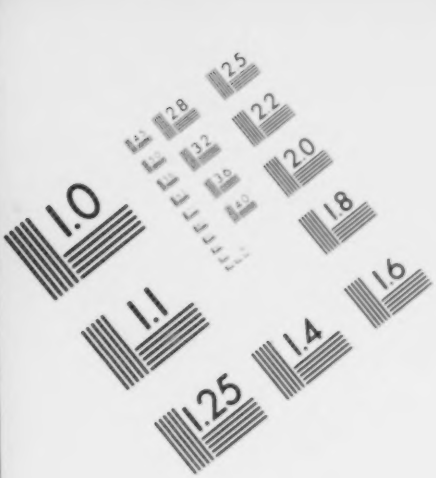
Nation	Population and exclusion rate*	Whether met sampling standards
SWEDEN	Students in their final year, Grade 12, of the Natural Science or Technology lines Exclusion rate: 0%	School participation rate before replacement: 95% Combined participation rate: 89%
SWITZERLAND	Students in their final year, Grade 12 or 13, of the the *Maturitätsschule (gymnasium)* in schools and programs (A-E) with federal recognition Exclusion rate: 3%	School participation rate before replacement: 99% Combined participation rate: 87%
(UNITED STATES)	Students in Grade 12 who had taken Advanced Placement physics or physics Exclusion rate: 4%	School participation rate before replacement: 77% **Combined participation rate: 68%**

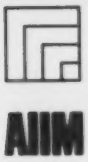
* Sample exclusion rates are based on all students in the final year of secondary school, not just those eligible to participate in the physics assessment.

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. Specific deviations from these guidelines are bolded.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Appendix A, Tables B.4 and B.12, and Figure B.6. Chestnut Hill, MA: Boston College.

APPENDIX 2
NATIONAL AVERAGE SCORES, PERCENTILES OF ACHIEVEMENT, AND STANDARD ERRORS



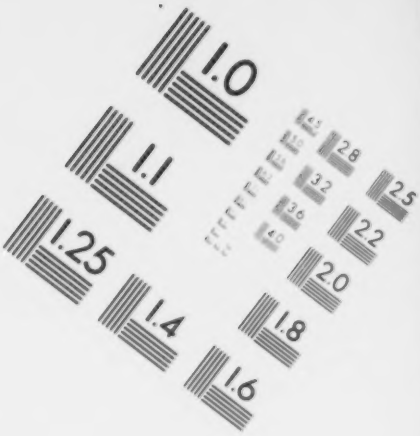


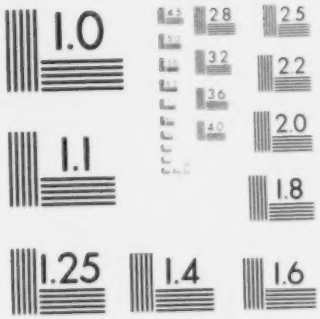
AIIM

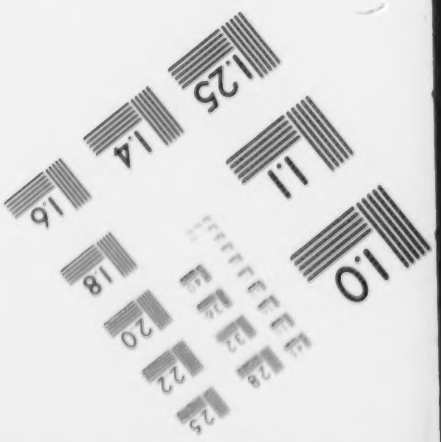
Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202







MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

TABLE A2.1

National Average Scores and Standard Errors: Mathematics and Science General Knowledge

The 95 percent "plus or minus" confidence interval around each nation's score is two times the standard error.

NATION	MATHEMATICS GENERAL KNOWLEDGE		SCIENCE GENERAL KNOWLEDGE	
	AVERAGE	STANDARD ERROR	AVERAGE	STANDARD ERROR
(AUSTRALIA)	522	9.3	527	9.8
(AUSTRIA)	518	5.3	520	5.6
(CANADA)	519	2.8	532	2.6
(CYPRUS)	446	2.5	448	3.0
CZECH REPUBLIC	466	12.3	487	8.8
(DENMARK)	547	3.3	509	3.6
(FRANCE)	523	5.1	487	5.1
(GERMANY)	495	5.9	497	5.1
HUNGARY	483	3.2	471	3.0
(ICELAND)	534	2.0	549	1.5
(ITALY)	476	5.5	475	5.3
(LITHUANIA)	469	6.1	461	5.7
(NETHERLANDS)	560	4.7	558	5.3
NEW ZEALAND	522	4.5	529	5.2
(NORWAY)	528	4.1	544	4.1
(RUSSIAN FEDERATION)	471	6.2	481	5.7
(SLOVENIA)	512	8.3	517	8.2
(SOUTH AFRICA)	356	8.3	349	10.5
SWEDEN	552	4.3	559	4.4
SWITZERLAND	540	5.8	523	5.3
(UNITED STATES)	**461**	**3.2**	**480**	**3.3**

MATHEMATICS GENERAL KNOWLEDGE INTERNATIONAL AVERAGE = 500

SCIENCE GENERAL KNOWLEDGE INTERNATIONAL AVERAGE = 500

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Tables 2.1 and 2.2. Chestnut Hill, MA: Boston College.

TABLE A2.2

National Average Scores and Standard Errors: Physics and Advanced Mathematics

The 95 percent "plus or minus" confidence interval around each nation's score is two times the standard error.

NATION	PHYSICS		ADVANCED MATHEMATICS	
	AVERAGE	STANDARD ERROR	AVERAGE	STANDARD ERROR
(AUSTRALIA)	518	6.2	525	11.6
(AUSTRIA)	435	6.4	436	7.2
(CANADA)*	485	3.3	509	4.3
(CYPRUS)	494	5.8	518	4.3
CZECH REPUBLIC	451	6.2	469	11.2
(DENMARK)	534	4.2	522	3.4
FRANCE	466	3.8	557	3.9
(GERMANY)	522	11.9	465	5.6
GREECE	486	5.6	513	6.0
(ITALY)	—	—	474	9.6
(LATVIA)	488	21.5	—	—
(LITHUANIA)	—	—	516	2.6
NORWAY	581	6.5	—	—
(RUSSIAN FEDERATION)	532	15.0	533	10.5
(SLOVENIA)	523	15.5	475	9.2
SWEDEN	573	3.9	512	4.4
SWITZERLAND	488	3.5	533	5.0
(UNITED STATES)	**423**	**3.3**	**442**	**5.9**

PHYSICS INTERNATIONAL AVERAGE = 501

ADVANCED MATHEMATICS INTERNATIONAL AVERAGE = 501

— Data not available because nation did not participate in the assessment.

* Canada did not meet international sampling and other guidelines for the physics assessment, but did for the advanced mathematics assessment. See Appendix 1 for details.

NOTE: Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Tables 5.1 and 8.1. Chestnut Hill, MA: Boston College.

TABLE A2.3

Percentiles Of Achievement In Mathematics General Knowledge: Final Year Of Secondary School

NATION	5th Percentile		25th Percentile		50th Percentile		75th Percentile		95th Percentile	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)
(AUSTRALIA)	357	(17.5)	459	(9.4)	523	(8.6)	585	(9.5)	684	(10.4)
(AUSTRIA)	393	(9.2)	461	(7.9)	515	(6.4)	573	(6.4)	653	(8.9)
(CANADA)	375	(5.8)	457	(4.6)	516	(4.5)	579	(3.8)	674	(5.3)
(CYPRUS)	329	(6.0)	395	(2.2)	442	(5.0)	493	(4.0)	572	(3.9)
CZECH REPUBLIC	328	(12.2)	394	(10.3)	450	(15.9)	530	(16.5)	648	(13.6)
(DENMARK)	406	(8.2)	487	(5.6)	548	(6.4)	609	(4.7)	689	(6.2)
(FRANCE)	392	(8.6)	468	(6.3)	523	(3.7)	578	(6.9)	655	(9.9)
(GERMANY)	347	(10.5)	432	(11.3)	494	(6.7)	554	(8.9)	652	(8.0)
HUNGARY	343	(3.8)	417	(3.1)	477	(3.8)	545	(3.5)	644	(6.6)
(ICELAND)	393	(5.3)	472	(4.0)	531	(3.0)	592	(3.2)	683	(6.6)
(ITALY)	336	(15.3)	417	(7.5)	475	(6.3)	534	(4.6)	619	(11.7)
(LITHUANIA)	329	(8.8)	412	(9.1)	470	(7.0)	529	(8.3)	606	(5.4)
(NETHERLANDS)	407	(5.7)	498	(7.1)	565	(6.1)	622	(5.2)	704	(16.0)
NEW ZEALAND	358	(7.4)	453	(7.0)	523	(6.3)	589	(5.2)	685	(6.7)
(NORWAY)	384	(7.7)	461	(6.1)	523	(4.1)	592	(4.5)	691	(6.8)
(RUSSIAN FEDERATION)	342	(6.4)	410	(4.8)	464	(6.0)	528	(7.8)	622	(16.6)
(SLOVENIA)	365	(13.7)	451	(8.5)	516	(7.4)	573	(6.6)	652	(5.7)
(SOUTH AFRICA)	264	(3.2)	304	(3.8)	337	(4.9)	380	(10.4)	532	(33.7)
SWEDEN	396	(6.4)	483	(5.1)	546	(4.8)	620	(4.1)	722	(6.8)
SWITZERLAND	395	(7.4)	478	(7.9)	539	(7.9)	601	(5.5)	684	(5.3)
(UNITED STATES)	**325**	**(4.4)**	**395**	**(3.8)**	**454**	**(4.4)**	**521**	**(6.7)**	**621**	**(7.4)**

NOTES:
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.
"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School* Table E.2. Chestnut Hill, MA: Boston College.

TABLE A2.4

PERCENTILES OF ACHIEVEMENT IN SCIENCE GENERAL KNOWLEDGE: FINAL YEAR OF SECONDARY SCHOOL

NATION	5th Percentile		25th Percentile		50th Percentile		75th Percentile		95th Percentile	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)
(AUSTRALIA)	361	(14.5)	462	(12.2)	525	(8.5)	591	(13.6)	689	(4.0)
(AUSTRIA)	388	(5.6)	460	(8.3)	513	(7.3)	575	(9.6)	672	(23.5)
(CANADA)	396	(7.1)	475	(5.8)	529	(3.6)	586	(3.8)	673	(5.2)
(CYPRUS)	319	(8.7)	392	(11.6)	443	(5.6)	499	(7.5)	599	(10.8)
CZECH REPUBLIC	349	(9.5)	424	(9.2)	477	(11.6)	540	(12.1)	655	(12.8)
(DENMARK)	369	(6.1)	448	(4.9)	505	(5.6)	568	(7.0)	657	(5.4)
(FRANCE)	358	(7.9)	434	(5.4)	485	(9.4)	542	(7.9)	618	(5.6)
(GERMANY)	350	(12.2)	437	(7.4)	494	(6.7)	556	(6.3)	649	(11.1)
HUNGARY	342	(2.9)	410	(3.5)	463	(2.2)	524	(3.7)	624	(6.1)
(ICELAND)	429	(5.0)	497	(1.9)	545	(3.3)	598	(2.1)	680	(3.8)
(ITALY)	339	(11.4)	417	(6.5)	470	(4.6)	528	(6.0)	624	(17.2)
(LITHUANIA)	324	(13.5)	403	(7.5)	460	(7.4)	517	(4.6)	601	(9.1)
(NETHERLANDS)	421	(9.0)	498	(6.1)	556	(6.4)	616	(10.5)	702	(19.8)
NEW ZEALAND	369	(16.8)	467	(8.9)	530	(7.0)	592	(4.4)	683	(5.2)
(NORWAY)	404	(6.9)	480	(5.2)	539	(2.7)	600	(7.4)	706	(11.6)
(RUSSIAN FEDERATION)	338	(6.1)	418	(6.9)	476	(9.3)	541	(9.2)	638	(13.7)
(SLOVENIA)	384	(10.1)	459	(8.7)	514	(8.7)	571	(10.3)	662	(22.5)
(SOUTH AFRICA)	228	(4.8)	282	(4.3)	325	(6.3)	390	(18.2)	550	(22.1)
SWEDEN	420	(9.4)	495	(4.3)	551	(4.2)	617	(5.5)	724	(9.2)
SWITZERLAND	375	(10.6)	459	(6.9)	521	(5.0)	584	(4.9)	681	(9.2)
(UNITED STATES)	**332**	**(8.0)**	**416**	**(4.6)**	**477**	**(3.3)**	**541**	**(4.9)**	**640**	**(8.0)**

NOTES:
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.
"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table E.3. Chestnut Hill, MA: Boston College.

TABLE A2.5

Percentiles Of Achievement In Advanced Mathematics: Final Year Of Secondary School

NATION	5th Percentile		25th Percentile		50th Percentile		75th Percentile		95th Percentile	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)
(AUSTRALIA)	337	(30.1)	456	(17.5)	530	(9.0)	597	(10.4)	692	(21.1)
(AUSTRIA)	283	(15.2)	379	(11.4)	443	(7.9)	497	(8.8)	577	(16.4)
CANADA	352	(7.1)	443	(5.4)	508	(4.8)	576	(7.2)	676	(10.1)
(CYPRUS)	371	(23.0)	465	(5.7)	523	(10.4)	574	(5.2)	651	(15.8)
CZECH REPUBLIC	320	(12.7)	399	(9.2)	454	(10.4)	524	(15.6)	665	(20.2)
(DENMARK)	403	(5.6)	474	(3.8)	523	(2.3)	572	(4.8)	643	(6.9)
FRANCE	439	(5.5)	511	(5.1)	558	(5.5)	603	(6.4)	673	(8.4)
(GERMANY)	328	(9.3)	408	(8.0)	463	(5.7)	522	(5.6)	605	(6.9)
GREECE	321	(35.1)	454	(11.6)	521	(6.4)	585	(5.1)	668	(12.7)
(ITALY)	314	(14.9)	419	(13.4)	477	(10.3)	534	(8.3)	622	(22.7)
(LITHUANIA)	388	(12.2)	461	(5.5)	512	(3.6)	567	(3.3)	666	(16.9)
(RUSSIAN FEDERATION)	360	(9.3)	465	(9.3)	539	(12.7)	618	(9.4)	730	(22.4)
(SLOVENIA)	330	(10.2)	408	(9.5)	473	(10.1)	537	(8.5)	630	(20.4)
SWEDEN	375	(7.9)	458	(10.5)	513	(11.4)	568	(7.0)	653	(13.6)
SWITZERLAND	401	(5.6)	473	(6.2)	525	(7.9)	587	(5.9)	691	(3.4)
(UNITED STATES)	**292**	**(3.8)**	**375**	**(7.1)**	**437**	**(6.4)**	**504**	**(6.1)**	**609**	**(8.9)**

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table E.4. Chestnut Hill, MA: Boston College.

TABLE A2.6

PERCENTILES OF ACHIEVEMENT IN PHYSICS: FINAL YEAR OF SECONDARY SCHOOL

NATION	5th Percentile		25th Percentile		50th Percentile		75th Percentile		95th Percentile	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)
(AUSTRALIA)	386	(11.8)	461	(3.3)	517	(6.6)	570	(8.5)	656	(11.9)
(AUSTRIA)	306	(11.9)	379	(11.3)	427	(5.9)	486	(10.1)	581	(22.3)
(CANADA)	346	(5.1)	429	(2.9)	482	(4.4)	539	(7.3)	633	(14.3)
(CYPRUS)	325	(8.0)	434	(10.9)	487	(4.9)	551	(9.0)	681	(28.8)
CZECH REPUBLIC	337	(4.5)	397	(6.2)	440	(6.6)	493	(12.3)	605	(29.5)
(DENMARK)	397	(8.4)	478	(4.3)	535	(5.9)	588	(6.1)	677	(15.2)
FRANCE	358	(9.4)	423	(6.8)	465	(4.1)	509	(3.1)	574	(8.3)
(GERMANY)	374	(13.2)	458	(16.2)	519	(12.0)	580	(19.1)	688	(10.1)
GREECE	333	(18.9)	431	(5.7)	495	(7.7)	545	(6.3)	619	(8.2)
(LATVIA)	348	(12.2)	418	(15.7)	474	(19.2)	540	(36.5)	687	(31.5)
NORWAY	432	(6.3)	517	(11.1)	578	(6.3)	646	(7.2)	727	(6.1)
(RUSSIAN FEDERATION)	368	(18.2)	468	(15.7)	544	(12.6)	619	(16.5)	722	(21.2)
(SLOVENIA)	332	(11.3)	457	(15.3)	528	(21.2)	598	(14.1)	689	(36.3)
SWEDEN	422	(12.2)	511	(8.9)	574	(6.6)	634	(6.6)	725	(6.7)
SWITZERLAND	353	(20.6)	430	(7.6)	479	(4.7)	540	(5.2)	648	(9.9)
(UNITED STATES)	**331**	**(4.7)**	**384**	**(4.0)**	**420**	**(4.2)**	**458**	**(6.4)**	**520**	**(6.6)**

NOTES:
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.
"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table E.5. Chestnut Hill, MA: Boston College.

APPENDIX 3
PERFORMANCE ON ASSESSMENT ITEM EXAMPLES BY COUNTRY

TABLE A3.1

Performance on Assessment Item Examples By Country: Mathematics and Science General Knowledge

NATION	PERCENTAGE OF STUDENTS RESPONDING CORRECTLY					
	MATHEMATICS GENERAL KNOWLEDGE ITEMS			SCIENCE GENERAL KNOWLEDGE ITEMS		
	FIGURE 2	FIGURE 3	FIGURE 4	FIGURE 6	FIGURE 7	FIGURE 8
(AUSTRALIA)	74.2	88.4	50.8	68.9	68.3	52.2
(AUSTRIA)	64.6	84.4	51.8	68.5	74.5	33.6
(CANADA)	74.4	79.6	44.7	69.0	84.3	55.0
(CYPRUS)	53.2	53.8	21.6	57.7	82.3	26.7
CZECH REPUBLIC	52.6	65.8	38.4	50.2	91.7	36.7
(DENMARK)	75.0	78.0	58.1	64.4	83.5	36.2
(FRANCE)	74.0	71.3	48.3	47.8	86.2	28.3
(GERMANY)	59.1	74.3	45.7	65.3	66.2	18.3
HUNGARY	65.1	55.8	31.6	67.2	67.6	26.6
(ICELAND)	73.3	73.8	54.4	78.1	92.6	59.8
(ITALY)	59.6	61.9	33.5	53.6	78.0	23.5
(LITHUANIA)	61.2	61.2	42.0	45.3	68.0	34.4
(NETHERLANDS)	82.5	91.4	61.6	77.9	88.8	64.8
NEW ZEALAND	75.0	91.1	58.9	67.6	78.8	48.9
(NORWAY)	67.3	77.8	47.3	71.8	82.2	47.9
(RUSSIAN FEDERATION)	53.7	61.7	48.1	53.0	66.3	36.1
(SLOVENIA)	63.5	79.9	50.6	71.2	72.4	34.8
(SOUTH AFRICA)	22.5	59.6	14.1	18.9	38.7	11.7
SWEDEN	77.5	84.6	57.3	71.8	92.8	36.5
SWITZERLAND	67.3	74.7	59.0	70.3	72.9	28.7
(UNITED STATES)	**57.4**	**84.5**	**32.0**	**41.7**	**77.9**	**40.2**
INTERNATIONAL AVERAGE	**64.4**	**74.0**	**45.2**	**61.0**	**76.9**	**37.2**

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

SOURCE: Third International Math and Science Study International Study Center, *P-Value Almanac for Achievement Items. Population 3 - Literacy.* Chestnut Hill, MA: Boston College.

TABLE A3.2

Performance on Assessment Item Examples By Country: Physics and Advanced Mathematics

NATION	PERCENTAGE OF STUDENTS RESPONDING CORRECTLY					
	ADVANCED MATHEMATICS ITEMS			PHYSICS ITEMS		
	FIGURE 13	FIGURE 14	FIGURE 15	FIGURE 19	FIGURE 20	FIGURE 21
(AUSTRALIA)	60.0	76.1	34.5	51.1	60.5	53.3
(AUSTRIA)	22.9	36.6	19.0	73.1	47.9	50.6
(CANADA)	56.4	60.9	28.4	54.5	45.1	22.0
(CYPRUS)	62.9	35.1	51.2	91.5	33.0	67.9
CZECH REPUBLIC	44.2	42.9	24.6	70.3	29.4	3.5
(DENMARK)	39.9	66.9	38.7	77.1	33.7	40.9
FRANCE	64.5	61.9	38.6	52.5	16.9	17.9
(GERMANY)	31.1	46.0	26.5	(1)	42.6	59.6
GREECE	65.5	29.1	32.0	83.2	52.8	40.1
(ITALY)	45.5	33.7	41.8	—	—	—
(LATVIA)	—	—	—	66.4	39.3	42.9
(LITHUANIA)	48.1	48.9	31.1	—	—	—
NORWAY	—	—	—	81.8	44.4	44.5
(RUSSIAN FEDERATION)	61.7	35.4	42.9	72.0	43.2	29.2
(SLOVENIA)	39.8	39.9	25.2	82.8	49.1	53.8
SWEDEN	50.0	64.4	48.6	75.3	31.5	19.8
SWITZERLAND	62.9	62.5	43.6	71.3	43.2	29.7
(UNITED STATES)	**18.9**	**62.4**	**27.4**	**40.8**	**49.0**	**12.0**
INTERNATIONAL AVERAGE	**48.3**	**50.2**	**34.6**	**69.6**	**41.4**	**36.7**

— Did not participate in the assessment.

1. Canada did not meet international sampling and other guidelines for the physics assessment, but did for the advanced mathematics assessment. See Appendix 1 for details.

2. Data not available.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

SOURCES: Third International Math and Science Study International Study Center. *P-Value Almanac for Achievement Items. Population 3 - Advanced Mathematics*. Chestnut Hill, MA: Boston College.TIMSS International Study Center. *P-Value Almanac for Achievement Items. Population 3 - Physics*. Chestnut Hill, MA: Boston College.

APPENDIX 4
SCORES AND STANDARD ERRORS FOR U.S. AP AND NON-AP PHYSICS AND CALCULUS STUDENTS

TABLE A4.1

U.S. AP and Non-AP Calculus Students' Scores By Content Area

CONTENT AREA	NON-AP CALCULUS STUDENTS		AP CALCULUS STUDENTS	
	AVERAGE	STANDARD ERROR	AVERAGE	STANDARD ERROR
NUMBERS AND EQUATIONS	459	7.9	520	5.2
CALCULUS	455	6.8	523	7.2
GEOMETRY	421	8.2	484	5.3
OVERALL	445	8.5	513	5.4

SOURCE: Third International Mathematics and Science Study, unpublished tabulations

TABLE A4.2

U.S. AP and Non-AP Physics Students' Scores By Content Area

CONTENT AREA	NON-AP PHYSICS STUDENTS		AP PHYSICS STUDENTS	
	AVERAGE	STANDARD ERROR	AVERAGE	STANDARD ERROR
MECHANICS	417	2.6	460	8.4
ELECTRICITY/ MAGNETISM	416	3.0	463	8.9
HEAT	474	3.0	507	7.1
WAVE PHENOMENA	448	2.3	487	6.1
MODERN PHYSICS	453	2.2	497	10.4
OVERALL	418	3.1	474	11.2

SOURCE: Third International Mathematics and Science Study, unpublished tabulations

APPENDIX 5
ADDITIONAL SUPPORTING MATERIALS

TABLE A5.1

MATHEMATICS PERFORMANCE AT EIGHTH GRADE AND FINAL YEAR OF SECONDARY SCHOOL FOR THE 20 COUNTRIES THAT PARTICIPATED IN TIMSS AT BOTH GRADE LEVELS

NATION	STANDING RELATIVE TO THE INTERNATIONAL AVERAGE[1,2]	
	EIGHTH GRADE	FINAL YEAR
(AUSTRALIA)	ABOVE	SAME
(AUSTRIA)	ABOVE	ABOVE
(CANADA)	ABOVE	ABOVE
(CYPRUS)	BELOW	BELOW
CZECH REPUBLIC	ABOVE	SAME
(DENMARK)	SAME	ABOVE
(FRANCE)	ABOVE	ABOVE
(GERMANY)	SAME	SAME
HUNGARY	ABOVE	BELOW
(ICELAND)	BELOW	ABOVE
(LITHUANIA)	BELOW	BELOW
(NETHERLANDS)	ABOVE	ABOVE
NEW ZEALAND	SAME	ABOVE
(NORWAY)	BELOW	ABOVE
(RUSSIAN FEDERATION)	ABOVE	BELOW
(SLOVENIA)	ABOVE	SAME
(SOUTH AFRICA)	BELOW	BELOW
SWEDEN	SAME	ABOVE
SWITZERLAND	ABOVE	ABOVE
(UNITED STATES)	**SAME[3]**	**BELOW**

COMPARISON OF STANDING RELATIVE TO THE INTERNATIONAL AVERAGE IN EIGHTH GRADE AND FINAL YEAR OF SECONDARY SCHOOL

HIGHER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN EIGHTH GRADE

(DENMARK)[4]
(ICELAND)
NEW ZEALAND[6]
(NORWAY)[4]
SWEDEN[4]

SIMILAR IN FINAL YEAR OF SECONDARY SCHOOL AS IN EIGHTH GRADE

(AUSTRIA)
(CANADA)
(CYPRUS)
(FRANCE)
(GERMANY)
(LITHUANIA)
(NETHERLANDS)
(SOUTH AFRICA)
SWITZERLAND[5]

LOWER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN EIGHTH GRADE

(AUSTRALIA)[6]
CZECH REPUBLIC
HUNGARY
(RUSSIAN FEDERATION)[5]
(SLOVENIA)
(UNITED STATES)

1. Above: Nation's performance higher than the average at that grade for the twenty nations.
   Same: Nation's performance not significantly different from the average at that grade for the twenty nations.
   Below: Nation's performance lower than the average at that grade for the twenty nations.
2. International average is the average of the national figures for the twenty nations.
3. U.S. average performance is below the international average based on all 41 countries that participated in the eighth grade portion of TIMSS.
4. Based on standing relative to the international average in seventh grade.
5. Based on standing relative to the international average in seventh or eighth grade, depending upon the system in place in each canton (Switzerland) or age starting school (Russian Federation).
6. Based on standing relative to the international average in eighth or ninth grade, depending upon the system in place in each state/territory (Australia) or age beginning primary school (New Zealand).

NOTE: Nations not meeting international sampling and other guidelines in the final year of secondary school assessment are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 2 and Figure 2.3. Chestnut Hill, MA: Boston College., Mullis et al. (1996). *Mathematics Achievement in the Middle School Years.* Table 2. Chestnut Hill, MA: Boston College.

TABLE A5.2

Mathematics Performance at Fourth Grade and Final Year of Secondary School for the 12 Countries that Participated in TIMSS at Both Grade Levels

NATION	STANDING RELATIVE TO THE INTERNATIONAL AVERAGE[1, 2]	
	FOURTH GRADE	FINAL YEAR
(AUSTRALIA)	ABOVE	SAME
(AUSTRIA)	ABOVE	SAME
(CANADA)	SAME	SAME
(CYPRUS)	BELOW	BELOW
CZECH REPUBLIC	ABOVE	SAME
HUNGARY	ABOVE	BELOW
(ICELAND)	BELOW	ABOVE
(NETHERLANDS)	ABOVE	ABOVE
NEW ZEALAND	BELOW	SAME
(NORWAY)	BELOW	SAME
(SLOVENIA)	ABOVE	SAME
(UNITED STATES)	**ABOVE**	**BELOW**

COMPARISON OF STANDING RELATIVE TO THE INTERNATIONAL AVERAGE IN FOURTH GRADE AND FINAL YEAR OF SECONDARY SCHOOL

HIGHER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN FOURTH GRADE
(ICELAND)
NEW ZEALAND[4]
(NORWAY)[3]

SIMILAR IN FINAL YEAR OF SECONDARY SCHOOL AS IN FOURTH GRADE
(CANADA)
(CYPRUS)
(NETHERLANDS)

LOWER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN FOURTH GRADE
(AUSTRALIA)[4]
(AUSTRIA)
CZECH REPUBLIC
HUNGARY
(SLOVENIA)
(UNITED STATES)

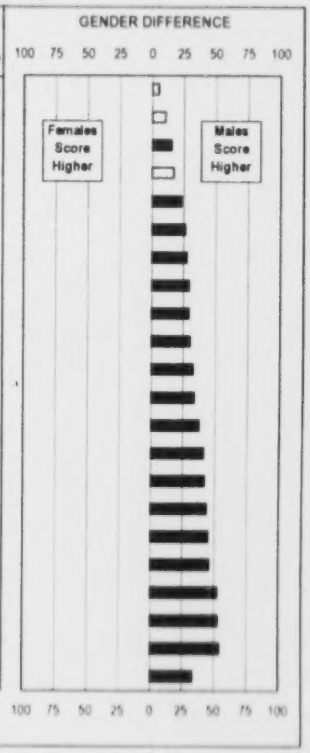
1. Above: Nation's performance higher than the average at that grade for the twelve nations.
   Same: Nation's performance not significantly different from the average at that grade for the twelve nations.
   Below: Nation's performance lower than the average at that grade for the twelve nations.
2. International average is the average of the national figures for the twelve nations.
3. Based on standing relative to international average in third grade.
4. Based on standing relative to international average in fourth or fifth grade, depending upon the system in place in each state/territory (Australia) or age beginning primary school (New Zealand).

NOTE: Nations not meeting international sampling and other guidelines in the final year of secondary school assessment are shown in parentheses. See Appendix I for details for each country.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 2.1. Chestnut Hill, MA: Boston College; and Martin et al. (1997). *Mathematics Achievement in the Primary School Years*. Tables 2 and 1.1. Chestnut Hill, MA: Boston College.

TABLE A5.3
ACHIEVEMENT IN MATHEMATICS GENERAL KNOWLEDGE BY GENDER FOR STUDENTS IN THEIR FINAL YEAR OF SECONDARY SCHOOL

NATION[2]	MALES		FEMALES		DIFFERENCE[1]	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)		(S.E.)
HUNGARY	485	(4.9)	481	(4.8)	5	(6.9)
(UNITED STATES)	**466**	**(4.1)**	**456**	**(3.6)**	**11**	**(5.5)**
(CYPRUS)	454	(4.9)	439	(3.7)	15	(6.1)
(SOUTH AFRICA)	365	(9.3)	348	(10.8)	17	(14.3)
(LITHUANIA)	485	(7.3)	461	(7.7)	23	(10.6)
(ITALY)	490	(7.4)	464	(6.0)	26	(9.5)
(RUSSIAN FEDERATION)	488	(6.5)	460	(6.6)	27	(9.2)
(GERMANY)	509	(8.8)	480	(8.8)	29	(12.4)
NEW ZEALAND	536	(4.9)	507	(6.2)	29	(7.9)
(AUSTRALIA)	540	(10.3)	510	(9.3)	30	(13.9)
SWITZERLAND	555	(6.4)	522	(7.4)	33	(9.8)
(CANADA)	537	(3.8)	504	(3.5)	34	(5.2)
(FRANCE)	544	(5.6)	506	(5.3)	38	(7.7)
(AUSTRIA)	545	(7.2)	503	(5.5)	41	(9.0)
SWEDEN	573	(5.9)	531	(3.9)	42	(7.0)
(ICELAND)	558	(3.4)	514	(2.2)	44	(4.1)
CZECH REPUBLIC	488	(11.3)	443	(16.8)	45	(20.2)
(SLOVENIA)	535	(12.7)	490	(8.0)	46	(15.0)
(DENMARK)	575	(4.0)	523	(4.0)	52	(5.7)
(NETHERLANDS)	585	(5.6)	533	(5.9)	53	(8.2)
(NORWAY)	555	(5.3)	501	(4.8)	54	(7.1)
INTERNATIONAL AVERAGE	518	(1.5)	485	(1.6)	33	(2.2)



■ Gender differences within country significant
□ Gender differences within country not significant

1. Difference is calculated by subtracting average females' score from average males' score, based on unrounded averages.
2. Nations ordered based on size of difference between males' and females' scores, from lowest to highest.

NOTES:
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.
International average is the average of the national figures.
"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 2.4. Chestnut Hill, MA: Boston College.

TABLE A5.4

Science Performance at Eighth Grade and Final Year of Secondary School for the 20 Countries that Participated in TIMSS at Both Grade Levels

NATION	STANDING RELATIVE TO THE INTERNATIONAL AVERAGE[1, 2]	
	EIGHTH GRADE	FINAL YEAR
(AUSTRALIA)	ABOVE	SAME
(AUSTRIA)	ABOVE	ABOVE
(CANADA)	ABOVE	ABOVE
(CYPRUS)	BELOW	BELOW
CZECH REPUBLIC	ABOVE	SAME
(DENMARK)	BELOW	SAME
(FRANCE)	BELOW	SAME
(GERMANY)	ABOVE	SAME
HUNGARY	ABOVE	BELOW
(ICELAND)	BELOW	ABOVE
(LITHUANIA)	BELOW	BELOW
(NETHERLANDS)	ABOVE	ABOVE
NEW ZEALAND	SAME	ABOVE
(NORWAY)	ABOVE	ABOVE
(RUSSIAN FEDERATION)	ABOVE	BELOW
(SLOVENIA)	ABOVE	SAME
(SOUTH AFRICA)	BELOW	BELOW
SWEDEN	ABOVE	ABOVE
SWITZERLAND	SAME	ABOVE
(UNITED STATES)	**ABOVE**	**BELOW**

COMPARISON OF STANDING RELATIVE TO THE INTERNATIONAL AVERAGE IN EIGHTH GRADE AND FINAL YEAR OF SECONDARY SCHOOL

HIGHER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN EIGHTH GRADE
(DENMARK)[3]
(FRANCE)
(ICELAND)
NEW ZEALAND[4]
SWITZERLAND[5]

SIMILAR IN FINAL YEAR OF SECONDARY SCHOOL AS IN EIGHTH GRADE
(AUSTRIA)
(CANADA)
(CYPRUS)
(LITHUANIA)
(NETHERLANDS)
(NORWAY)[3]
(SOUTH AFRICA)
SWEDEN[3]

LOWER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN EIGHTH GRADE
(AUSTRALIA)[4]
CZECH REPUBLIC
(GERMANY)
HUNGARY
(RUSSIAN FEDERATION)[5]
(SLOVENIA)
(UNITED STATES)

1. Above: Nation's performance higher than the average at that grade for the twenty nations.
   Same: Nation's performance not significantly different from the average at that grade for the twenty nations.
   Below: Nation's performance lower than the average at that grade for the twenty nations.
2. International average is the average of the national figures for the twenty nations.
3. Based on standing relative to the international average in seventh grade.
4. Based on standing relative to the international average in eighth or ninth grade, depending upon the system in place in each state/territory (Australia) or age beginning primary school (New Zealand).
5. Based on standing relative to the international average in seventh or eighth grade, depending upon the system in place in each canton (Switzerland) or age starting school (Russian Federation).

NOTE: Nations not meeting international sampling and other guidelines in the final year of secondary school assessment are shown in parentheses. See Appendix 1 for details for each country.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 2 and Figure 2.4. Chestnut Hill, MA: Boston College., Mullis et al. (1996). *Mathematics Achievement in the Middle School Years*. Table 2. Chestnut Hill, MA: Boston College.

TABLE A5.5

Science Performance at Fourth Grade and Final Year of Secondary School for the 12 Countries that Participated in TIMSS at Both Grade Levels

NATION	STANDING RELATIVE TO THE INTERNATIONAL AVERAGE[1,2]	
	FOURTH GRADE	FINAL YEAR
(AUSTRALIA)	ABOVE	SAME
(AUSTRIA)	ABOVE	SAME
(CANADA)	SAME	ABOVE
(CYPRUS)	BELOW	BELOW
CZECH REPUBLIC	ABOVE	SAME
HUNGARY	SAME	BELOW
(ICELAND)	BELOW	ABOVE
(NETHERLANDS)	ABOVE	ABOVE
NEW ZEALAND	SAME	SAME
(NORWAY)	SAME	ABOVE
(SLOVENIA)	SAME	SAME
(UNITED STATES)	**ABOVE**	**BELOW**

COMPARISON OF STANDING RELATIVE TO THE INTERNATIONAL AVERAGE IN FOURTH GRADE AND FINAL YEAR OF SECONDARY SCHOOL

HIGHER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN FOURTH GRADE
(CANADA)
(ICELAND)
(NORWAY)[3]

SIMILAR IN FINAL YEAR OF SECONDARY SCHOOL AS IN FOURTH GRADE
(CYPRUS)
(NETHERLANDS)
NEW ZEALAND[4]
(SLOVENIA)

LOWER IN FINAL YEAR OF SECONDARY SCHOOL THAN IN FOURTH GRADE
(AUSTRALIA)[4]
(AUSTRIA)
CZECH REPUBLIC
HUNGARY
(UNITED STATES)

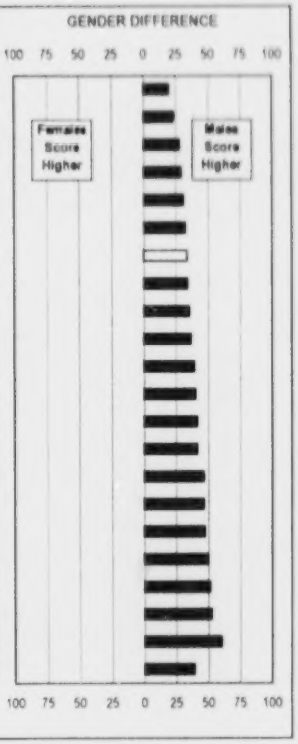
1. Above: Nation's performance higher than the average at that grade for the twelve nations.
   Same: Nation's performance not significantly different from the average at that grade for the twelve nations.
   Below: Nation's performance lower than the average at that grade for the twelve nations.
2. International average is the average of the national figures for the twelve nations.
3. Based on standing relative to the international average in third grade.
4. Based on standing relative to the international average in fourth or fifth grade, depending upon the system in place in each state/territory (Australia) or age beginning primary school (New Zealand).

NOTE: Nations not meeting international sampling and other guidelines in the final year of secondary school assessment are shown in parentheses. See Appendix 1 for details for each country.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 2.2. Chestnut Hill, MA: Boston College; and Martin et al. (1997). *Science Achievement in the Primary School Years.* Table 1.1. Chestnut Hill, MA: Boston College.

TABLE A5.6
ACHIEVEMENT IN SCIENCE GENERAL KNOWLEDGE BY GENDER FOR STUDENTS IN THEIR FINAL YEAR OF SECONDARY SCHOOL

NATION[2]	MALES		FEMALES		DIFFERENCE[1]	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)		(S.E.)
(CYPRUS)	459	(5.8)	439	(3.0)	20	(6.5)
(UNITED STATES)	**492**	**(4.5)**	**469**	**(3.9)**	**23**	**(5.9)**
(NEW ZEALAND)	543	(7.1)	515	(5.2)	28	(8.8)
(HUNGARY)	484	(4.2)	455	(4.3)	29	(6.0)
(LITHUANIA)	481	(6.4)	450	(7.3)	31	(9.7)
(CANADA)	550	(3.6)	518	(3.8)	32	(5.2)
(SOUTH AFRICA)	367	(11.5)	333	(13.0)	34	(17.4)
(AUSTRALIA)	547	(11.5)	513	(9.4)	34	(14.8)
(GERMANY)	514	(7.9)	478	(8.5)	35	(11.6)
(ITALY)	495	(6.7)	458	(5.6)	37	(8.8)
(FRANCE)	508	(6.7)	468	(4.8)	39	(8.3)
(SWITZERLAND)	540	(6.1)	500	(7.8)	40	(9.9)
(DENMARK)	532	(5.4)	490	(4.1)	41	(6.8)
(ICELAND)	572	(2.7)	530	(2.1)	41	(3.4)
(SLOVENIA)	541	(12.7)	494	(6.4)	47	(14.3)
(RUSSIAN FEDERATION)	510	(5.7)	463	(6.7)	47	(8.8)
(NETHERLANDS)	582	(5.7)	532	(6.2)	48	(8.4)
(SWEDEN)	585	(5.9)	534	(3.5)	50	(6.8)
(CZECH REPUBLIC)	512	(8.8)	460	(11.0)	51	(14.0)
(AUSTRIA)	554	(8.7)	501	(5.8)	53	(10.4)
(NORWAY)	574	(5.1)	513	(4.5)	61	(6.8)
INTERNATIONAL AVERAGE	521	(1.6)	482	(1.4)	39	(2.1)



■ Gender differences within country significant
□ Gender differences within country not significant

1. Difference is calculated by subtracting average females' score from average males' score, based on unrounded averages.
2. Nations ordered based on size of difference between males' and females' scores, from lowest to highest.

NOTES:
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.
International average is the average of the national figures.
"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 2.5. Chestnut Hill, MA: Boston College.

TABLE A5.7
ADVANCED MATHEMATICS AND ADVANCED SCIENCE STUDENTS AS A PROPORTION OF AGE COHORT AND PERFORMANCE ON ADVANCED MATHEMATICS AND ON PHYSICS ASSESSMENTS RELATIVE TO THE UNITED STATES

ADVANCED MATHEMATICS		ADVANCED SCIENCE/PHYSICS	
NATION AND PERFORMANCE RELATIVE TO THE U.S.	**PERCENTAGE OF AGE COHORT REPRESENTED**	**NATION AND PERFORMANCE RELATIVE TO THE U.S.**	**PERCENTAGE OF AGE COHORT REPRESENTED**
PERFORMED ABOVE THE U.S.			
(AUSTRALIA)	16	(AUSTRALIA)	13
CANADA	16	(CANADA)	14
(CYPRUS)	9	(CYPRUS)	9
(DENMARK)	21	CZECH REPUBLIC	11
FRANCE	20	(DENMARK)	3
GREECE	10	FRANCE	20
(LITHUANIA)	3	(GERMANY)	8
(RUSSIAN FEDERATION)	2	GREECE	10
(SLOVENIA)	75	(LATVIA)	3
SWEDEN	16	NORWAY	8
SWITZERLAND	14	(RUSSIAN FEDERATION)	2
		(SLOVENIA)	39
		SWEDEN	16
		SWITZERLAND	14
AVERAGE	18		12
PERFORMED SAME AS THE U.S.			
(AUSTRIA)	33	(AUSTRIA)	33
CZECH REPUBLIC	11		
(GERMANY)	26		
(ITALY)	14		
AVERAGE	21		33
(UNITED STATES)	**14**	**(UNITED STATES)**	**14**
INTERNATIONAL AVERAGE	19		14

NOTES:

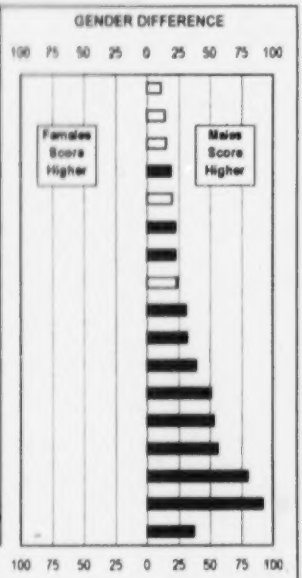
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

SOURCE: Mullis et. al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Figures 5.1 and 8.1, Tables 5.1 and 8.1. Chestnut Hill, MA: Boston College.

TABLE A5.8
GENDER DIFFERENCES IN ADVANCED MATHEMATICS ACHIEVEMENT FOR STUDENTS IN THEIR FINAL YEAR OF SECONDARY SCHOOL HAVING TAKEN ADVANCED MATHEMATICS

NATION[2]	MALES		FEMALES		DIFFERENCE[1]	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)		(S.E.)
GREECE	516	(6.6)	505	(10.2)	11	(12.1)
(AUSTRALIA)	531	(11.4)	517	(15.1)	14	(18.9)
(CYPRUS)	524	(4.4)	509	(6.4)	15	(7.8)
(DENMARK)	529	(4.4)	510	(4.8)	19	(6.3)
(SLOVENIA)	484	(11.5)	464	(11.0)	20	(15.9)
SWEDEN	519	(5.9)	496	(5.2)	23	(7.9)
FRANCE	567	(5.1)	543	(5.1)	23	(7.2)
(ITALY)	484	(10.6)	460	(14.1)	24	(17.7)
(UNITED STATES)	**467**	**(7.8)**	**436**	**(7.1)**	**31**	**(10.5)**
(GERMANY)	484	(6.5)	452	(6.6)	32	(9.2)
CANADA	528	(6.4)	489	(4.4)	39	(7.7)
(LITHUANIA)	542	(3.7)	490	(5.6)	51	(6.7)
(RUSSIAN FEDERATION)	568	(9.7)	515	(10.2)	53	(14.1)
SWITZERLAND	559	(5.6)	503	(5.7)	56	(8.0)
(AUSTRIA)	486	(7.3)	406	(8.6)	80	(11.2)
CZECH REPUBLIC	524	(13.0)	432	(8.9)	92	(15.7)
INTERNATIONAL AVERAGE	519	(2.0)	482	(2.2)	37	(2.9)



■ Gender differences within country significant
□ Gender differences within country not significant

1. Difference is calculated by subtracting average females' score from average males' score, based on unrounded averages.
2. Nations ordered based on size of difference between males' and females' scores, from lowest to highest.

NOTES

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 5.4. Chestnut Hill, MA: Boston College.

TABLE A5.9
ACHIEVEMENT IN ADVANCED MATHEMATICS CONTENT AREAS BY GENDER FOR STUDENTS HAVING TAKEN ADVANCED MATHEMATICS

NATION	ADVANCED MATHEMATICS CONTENT AREAS											
	NUMBERS & EQUATIONS (17 ITEMS)				CALCULUS (15 ITEMS)				GEOMETRY (23 ITEMS)			
	FEMALES		MALES		FEMALES		MALES		FEMALES		MALES	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)
(AUSTRALIA)	511	(11.2)	523	(9.9)	525	(12.2)	533	(13.6)	485	(13.8)	505	(14.1)
(AUSTRIA)	385	(9.3)	▲ 455	(6.2)	412	(7.3)	▲ 486	(6.9)	433	(9.6)	▲ 509	(7.7)
CANADA	496	(4.5)	▲ 526	(5.6)	484	(4.9)	▲ 521	(5.5)	482	(4.6)	▲ 516	(5.3)
(CYPRUS)	497	(7.0)	▲ 518	(6.5)	562	(8.0)	559	(5.0)	512	(8.5)	520	(5.2)
CZECH REPUBLIC	427	(10.5)	▲ 510	(11.3)	417	(8.3)	▲ 488	(11.0)	461	(7.2)	▲ 543	(12.1)
(DENMARK)	498	(3.5)	507	(3.6)	491	(5.4)	▲ 517	(4.3)	519	(4.0)	▲ 531	(4.2)
FRANCE	544	(3.9)	551	(5.4)	544	(4.1)	▲ 569	(4.3)	529	(4.8)	▲ 555	(5.7)
(GERMANY)	446	(5.1)	▲ 475	(6.2)	442	(5.2)	▲ 471	(5.6)	480	(5.6)	▲ 498	(7.0)
GREECE	537	(10.4)	540	(9.1)	536	(12.0)	540	(8.2)	485	(15.4)	505	(7.5)
(ITALY)	441	(14.1)	472	(10.6)	521	(13.5)	520	(11.4)	472	(14.5)	485	(10.4)
(LITHUANIA)	526	(5.4)	▲ 568	(3.0)	478	(4.8)	▲ 518	(4.3)	491	(5.8)	▲ 539	(3.6)
(RUSSIAN FEDERATION)	533	(9.8)	▲ 576	(9.6)	512	(10.9)	▲ 560	(8.9)	525	(10.5)	▲ 570	(8.9)
(SLOVENIA)	480	(10.8)	503	(13.0)	463	(7.9)	479	(8.2)	469	(8.9)	482	(9.6)
SWEDEN	511	(5.6)	▲ 529	(6.4)	472	(4.9)	484	(6.0)	476	(5.1)	▲ 500	(5.5)
SWITZERLAND	488	(5.7)	▲ 536	(5.7)	486	(6.2)	▲ 536	(6.8)	522	(5.9)	▲ 569	(3.8)
(UNITED STATES)	**447**	**(6.9)**	▲ **470**	**(6.1)**	**439**	**(6.1)**	▲ **460**	**(5.3)**	**408**	**(7.0)**	▲ **439**	**(5.9)**
INTERNATIONAL AVERAGE	485	(2.1)	▲ 516	(2.0)	487	(2.0)	▲ 515	(1.9)	484	(2.2)	▲ 517	(2.0)

▲ = Males' score is significantly higher than females' score.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

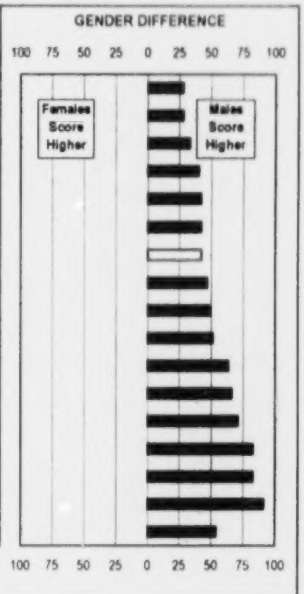
International average is the average of the national figures.

"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 6.2. Chestnut Hill, MA: Boston College.

TABLE A5.10
GENDER DIFFERENCES IN PHYSICS ACHIEVEMENT FOR STUDENTS IN THEIR FINAL YEAR OF SECONDARY SCHOOL HAVING TAKEN ADVANCED SCIENCE

NATION [2]	MALES		FEMALES		DIFFERENCE [1]	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)		(S.E.)
FRANCE	478	(4.2)	450	(5.6)	28	(7.0)
GREECE	495	(6.1)	468	(8.1)	28	(10.1)
(UNITED STATES)	**439**	**(4.3)**	**405**	**(3.1)**	**33**	**(5.3)**
(CYPRUS)	509	(8.9)	470	(7.1)	40	(11.4)
(AUSTRALIA)	532	(6.7)	490	(8.4)	42	(10.8)
(DENMARK)	542	(5.2)	500	(8.1)	42	(9.6)
(LATVIA)	509	(19.0)	467	(22.6)	42	(29.5)
(CANADA)	506	(6.0)	459	(6.3)	47	(8.7)
SWEDEN	589	(5.1)	540	(5.3)	49	(7.4)
NORWAY	594	(6.3)	544	(9.3)	51	(11.2)
(GERMANY)	542	(14.3)	479	(9.1)	64	(17.0)
(RUSSIAN FEDERATION)	575	(9.9)	509	(15.3)	66	(18.2)
(AUSTRIA)	479	(8.1)	408	(7.4)	71	(11.0)
CZECH REPUBLIC	503	(8.8)	419	(3.9)	83	(9.7)
SWITZERLAND	529	(5.2)	446	(3.6)	83	(6.3)
(SLOVENIA)	546	(16.3)	455	(18.7)	91	(24.8)
INTERNATIONAL AVERAGE	523	(2.4)	469	(2.6)	54	(3.5)



■ Gender differences within country significant
□ Gender differences within country not significant

1. Difference is calculated by subtracting average females' score from average males' score, based on unrounded averages.
2. Nations ordered based on size of difference between males' and females' scores, from lowest to highest.

NOTES:
Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.
International average is the average of the national figures.
"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 8.4. Chestnut Hill, MA: Boston College.

TABLE A5.11
ACHIEVEMENT IN PHYSICS CONTENT AREAS BY GENDER FOR ADVANCED SCIENCE STUDENTS

NATION	PHYSICS CONTENT AREAS											
	MECHANICS (17 ITEMS)				ELECTRICITY AND MAGNETISM (15 ITEMS)				HEAT (23 ITEMS)			
	FEMALES		MALES		FEMALES		MALES		FEMALES		MALES	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	VERAG	(S.E.)	VERAG	(S.E.)
(AUSTRALIA)	474	(6.8)	▲ 524	(7.8)	488	(8.3)	▲ 525	(6.7)	503	(6.2)	▲ 524	(5.0)
(AUSTRIA)	399	(6.3)	▲ 459	(6.6)	409	(6.9)	▲ 468	(9.1)	420	(6.8)	▲ 485	(8.0)
(CANADA)	440	(5.7)	▲ 499	(6.6)	468	(6.5)	▲ 497	(6.2)	492	(8.1)	▲ 520	(5.2)
(CYPRUS)	496	(10.3)	▲ 551	(9.6)	494	(7.4)	507	(8.5)	461	(11.2)	484	(9.8)
CZECH REPUBLIC	440	(4.8)	▲ 514	(8.4)	443	(3.3)	▲ 501	(8.7)	472	(4.5)	▲ 513	(6.6)
(DENMARK)	483	(10.2)	▲ 540	(5.5)	496	(7.8)	515	(4.5)	487	(9.6)	▲ 517	(5.3)
FRANCE	437	(5.5)	▲ 470	(5.6)	491	(5.2)	495	(4.2)	487	(5.7)	496	(4.0)
(GERMANY)	453	(10.6)	▲ 515	(9.6)	491	(7.7)	▲ 522	(12.1)	461	(10.6)	▲ 513	(6.3)
GREECE	489	(7.2)	▲ 525	(7.0)	515	(11.0)	522	(6.5)	460	(10.5)	▲ 490	(8.1)
(LATVIA)	468	(19.8)	509	(15.2)	474	(18.4)	496	(16.8)	484	(23.4)	523	(17.8)
NORWAY	523	(9.0)	▲ 589	(6.1)	549	(10.0)	570	(6.2)	511	(7.0)	▲ 545	(4.4)
(RUSSIAN FEDERATION)	507	(12.3)	▲ 563	(7.4)	519	(12.9)	▲ 575	(7.7)	501	(14.8)	▲ 555	(7.5)
(SLOVENIA)	487	(21.7)	▲ 576	(17.5)	470	(13.8)	▲ 522	(16.6)	470	(18.7)	▲ 538	(13.1)
SWEDEN	517	(4.4)	▲ 586	(4.6)	551	(4.7)	▲ 579	(4.8)	507	(5.3)	▲ 529	(5.8)
SWITZERLAND	444	(3.5)	▲ 519	(5.3)	452	(4.5)	▲ 507	(7.1)	480	(5.7)	▲ 538	(4.3)
(UNITED STATES)	**393**	**(2.8)**	▲ **448**	**(3.5)**	**409**	**(3.6)**	▲ **430**	**(3.5)**	**474**	**(2.7)**	**480**	**(4.2)**
INTERNATIONAL AVERAGE	466	(2.6)	▲ 524	(2.2)	483	(2.3)	▲ 514	(2.2)	479	(2.7)	▲ 516	(2.0)

▲ = Males' score is significantly higher than females' score

TABLE A5.11 (CONTINUED)
ACHIEVEMENT IN PHYSICS CONTENT AREAS BY GENDER FOR ADVANCED SCIENCE STUDENTS

NATION	PHYSICS CONTENT AREAS							
	WAVE PHENOMENA (10 ITEMS)				MODERN PHYSICS (14 ITEMS)			
	FEMALES		MALES		FEMALES		MALES	
	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)	AVERAGE	(S.E.)
(AUSTRALIA)	498	(7.2)	▲ 529	(9.0)	497	(7.8)	▲ 533	(6.7)
(AUSTRIA)	444	(9.7)	▲ 506	(7.3)	465	(6.1)	▲ 505	(9.9)
(CANADA)	476	(6.4)	▲ 497	(4.3)	471	(5.1)	▲ 513	(6.0)
(CYPRUS)	486	(8.4)	▲ 519	(10.4)	411	(9.9)	▲ 450	(7.7)
CZECH REPUBLIC	419	(4.9)	▲ 491	(7.2)	425	(4.6)	▲ 498	(6.9)
(DENMARK)	493	(10.0)	▲ 547	(6.3)	529	(7.4)	546	(6.0)
FRANCE	448	(4.6)	▲ 475	(5.6)	457	(4.1)	▲ 485	(4.3)
(GERMANY)	485	(10.1)	▲ 551	(12.7)	508	(13.5)	▲ 561	(15.3)
GREECE	444	(7.2)	457	(7.4)	426	(5.7)	▲ 456	(6.4)
(LATVIA)	480	(16.2)	515	(17.3)	470	(20.8)	505	(16.6)
NORWAY	519	(10.2)	▲ 575	(4.9)	549	(9.9)	▲ 585	(5.0)
(RUSSIAN FEDERATION)	487	(12.4)	▲ 539	(7.9)	520	(13.9)	▲ 561	(7.9)
(SLOVENIA)	446	(13.4)	▲ 538	(11.9)	458	(14.1)	▲ 528	(18.7)
SWEDEN	528	(5.9)	▲ 576	(6.1)	538	(6.2)	▲ 570	(3.3)
SWITZERLAND	460	(4.4)	▲ 533	(4.8)	457	(4.4)	▲ 519	(5.8)
(UNITED STATES)	**442**	**(3.0)**	▲ **480**	**(2.6)**	**446**	**(2.3)**	▲ **488**	**(3.6)**
INTERNATIONAL AVERAGE	472	(2.3)	▲ 519	(2.2)	477	(2.4)	▲ 518	(2.3)

▲ = Males' score is significantly higher than females' score.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix I for details for each country.

International average is the average of the national figures.

"S.E." is standard error.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Table 9.2. Chestnut Hill, MA: Boston College.

TABLE A5.12
EXTENT OF DIFFERENTIATION IN SECONDARY EDUCATION AND PERFORMANCE ON TIMSS GENERAL KNOWLEDGE ASSESSMENTS RELATIVE TO THE UNITED STATES

EXTENSIVE DIFFERENTIATION WITHIN AND BETWEEN SCHOOLS IN PROGRAMS FOR STUDENTS WITH DIFFERING ABILITIES OR INTERESTS	DIFFERENTIATION IN LENGTH OF SECONDARY EDUCATION	
	YES	NO
YES (SPECIALIZED AND MIXED SECONDARY SCHOOLS)	**(AUSTRIA)** CZECH REPUBLIC ***(FRANCE)*** ***(GERMANY)*** ***HUNGARY*** **(ICELAND)** (ITALY) (LITHUANIA) **(NETHERLANDS)** (RUSSIAN FEDERATION) **(SLOVENIA)** **SWEDEN** **SWITZERLAND**	*(CYPRUS)* **(DENMARK)** **(NORWAY)**
NO (COMPREHENSIVE SECONDARY SCHOOLS)	**(CANADA)** **NEW ZEALAND**	**(AUSTRALIA)** *(SOUTH AFRICA)* (UNITED STATES)

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

Bold: Nations that performed above the U.S. in both mathematics and science general knowledge.
Bold italic: Nations that performed above the U.S. in mathematics general knowledge only.
Regular: Nations that performed similar to the U.S. in both mathematics and science general knowledge.
Italic: Nations that performed below the U.S. in both mathematics and science general knowledge.

Greece and Latvia participated only in the physics and/or advanced mathematics assessments. For these countries:
Greece: Specialized/mixed schools and varying lengths of secondary schooling.
Latvia: Specialized/mixed schools and varying lengths of secondary schooling.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Appendix A. Chestnut Hill, MA: Boston College.

TABLE A5.13

Average Age of Students Assessed and Grades Included in General Knowledge Assessments Compared to Performance on Mathematics General Knowledge Assessment Relative to the United States

NATION AND PERFORMANCE RELATIVE TO THE U.S. IN MATHEMATICS GENERAL KNOWLEDGE	AVERAGE AGE OF STUDENTS PARTICIPATING IN GENERAL KNOWLEDGE ASSESSMENTS	END OF SECONDARY GRADES ASSESSED IN GENERAL KNOWLEDGE ASSESSMENTS					
		10	11	12	13	14	RANGE
PERFORMED ABOVE THE U.S.							
(AUSTRALIA)	17.7			X			12
(AUSTRIA)	19.1	X	X	X	X	X	10-14
(CANADA)	18.6			X	X	X	12-14
(DENMARK)	19.1			X			12
(FRANCE)	18.8		X	X	X		11-13
(GERMANY)	19.5			X	X		12-13
HUNGARY	17.6	X		X			10,12
ICELAND)	21.2			X	X	X	12-14
(NETHERLANDS)	18.5		X	X			11-12
NEW ZEALAND)	17.5		X	X			11-12
(NORWAY)	19.5			X			12
(SLOVENIA)	18.8		X	X			11-12
SWEDEN	18.9		X	X			11-12
SWITZERLAND)	19.8		X	X	X		11-13
AVERAGE	18.9						
PERFORMED SAME AS THE U.S.							
CZECH REPUBLIC	17.8	X	X	X	X		10-13
(ITALY)	18.7		X	X	X		11-13
(LITHUANIA)	18.1			X			12
(RUSSIAN FEDERATION)	16.9		X				11
PERFORMED BELOW THE U.S.							
(CYPRUS)	17.7			X			12
(SOUTH AFRICA)	20.1			X			12
AVERAGE (SAME AND BELOW)	18.2						
(UNITED STATES)	18.1			X			12
INTERNATIONAL AVERAGE	18.7						

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 1.1, Figure 2.1, and Appendix A. Chestnut Hill, MA: Boston College.

TABLE A5.14

SECONDARY ENROLLMENT AND COMPLETION COMPARED TO THE UNITED STATES

NATION AND PERFORMANCE RELATIVE TO THE U.S. IN MATHEMATICS GENERAL KNOWLEDGE	PERCENTAGE IN SECONDARY SCHOOL	PERCENTAGE 25-34-YEAR-OLDS COMPLETING SECONDARY EDUCATION	PERCENTAGE ENROLLED IN SECONDARY EDUCATION BY AGE			
			17	18	19	20
PERFORMED ABOVE THE U.S.						
(AUSTRALIA)	84	57	77	32	20	17
(AUSTRIA)	107	81	88	56	22	8
(CANADA)	88	84	69	34	10	—
(DENMARK)	114	69	82	71	52	31
(FRANCE)	106	86	91	60	34	15
(GERMANY)	101	89	93	82	57	31
HUNGARY	81	—	71	39	17	11
(ICELAND)	103	—	77	65	63	33
(NETHERLANDS)	93	70	91	69	47	32
NEW ZEALAND	104	64	74	33	17	13
(NORWAY)	116	88	90	83	33	19
(SLOVENIA)	85	—	—	—	—	—
SWEDEN	99	88	96	87	24	12
SWITZERLAND	91	88	82	75	52	23
AVERAGE	98	79	83	60	34	20
PERFORMED SAME AS THE U.S.						
CZECH REPUBLIC	86	91	72	30	6	3
(ITALY)	81	49	—	—	—	—
(LITHUANIA)	78	—	—	—	—	—
(RUSSIAN FEDERATION)	88	—	—	—	—	—
PERFORMED BELOW THE U.S.						
(CYPRUS)	95	—	—	—	—	—
(SOUTH AFRICA)	77	—	—	—	—	—
AVERAGE (SAME AND BELOW)	84	—	—	—	—	—
(UNITED STATES)	**97**	**87**	**75**	**22**	**4**	**2**
INTERNATIONAL AVERAGE	94	78	82	56	31	18

— Data not available.

* Percentage in secondary school represents gross enrollment of all ages at the secondary level as a percentage of school-age children as defined by each country. This may be reported in excess of 100% if some pupils are younger or older than the country's standard range of secondary school age.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

Percentage in secondary school, 1995; Percentage 25-34 year olds completing secondary education from National Labor Force surveys, 1995 or 1996; Percentage enrolled in secondary education by age refers to school year 1994/95 (except for Austria where data is for 1992/93 school year).

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 4 and Figure 2.1. Chestnut Hill, MA: Boston College; and Organisation for Economic Cooperation and Development. (1997). *Education at a Glance: OECD Indicators.* Tables A2.2a and C3.3. Paris: OECD.

TABLE A5.15

Centralization Of Decision-Making About Curriculum Syllabi And Performance On Mathematics And Science General Knowledge Assessments Relative To The United States

EXTENT OF CENTRALIZATION	NATION
NATIONALLY CENTRALIZED	**(AUSTRIA)** *(CYPRUS)* CZECH REPUBLIC **(DENMARK)** ***(FRANCE)*** (ITALY) (LITHUANIA) **NEW ZEALAND** **(NORWAY)** **(SLOVENIA)** *(SOUTH AFRICA)* **SWEDEN**
REGIONALLY CENTRALIZED	**(CANADA)** ***(GERMANY)*** **SWITZERLAND**
NOT CENTRALIZED	**(AUSTRALIA)** ***HUNGARY*** **(ICELAND)** **(NETHERLANDS)** (RUSSIAN FEDERATION) (UNITED STATES)

NOTES:

Countries are "Nationally Centralized" regarding curriculum if the highest level of decision-making authority within the education system (e.g., ministry of education) has exclusive responsibility for or gives final approval of the syllabi for courses of study. If curriculum syllabi are determined at the regional level (e.g., state, province, territory), a country is "Regionally Centralized." If syllabi for courses of study are not determined nationally or regionally, a country is "Not Centralized."

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

Bold: Nations that performed above the U.S. in both mathematics and science general knowledge.
Bold italic: Nations that performed above the U.S. in mathematics general knowledge only.
Regular: Nations that performed similar to the U.S. in both mathematics and science general knowledge.
Italic: Nations that performed below the U.S. in both mathematics and science general knowledge.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Figure 1. Chestnut Hill, MA: Boston College.

TABLE A5.16

Gross National Product Per Capita and Public Expenditure on Elementary and Secondary Education of TIMSS Nations Compared to Performance on The Mathematics General Knowledge Assessment Relative to the United States

NATION AND PERFORMANCE RELATIVE TO THE U.S. IN MATHEMATICS GENERAL KNOWLEDGE	GNP PER CAPITA (U.S. $)	PUBLIC EXPENDITURE ON ELEMENTARY/ SECONDARY EDUCATION AS PERCENT OF GNP	PUBLIC EXPENDITURE ON ELEMENTARY/ SECONDARY EDUCATION PER CAPITA (U.S. $)
PERFORMED ABOVE THE U.S.			
(AUSTRALIA)	$17,980	3.69	$663
(AUSTRIA)	24,950	4.24	1,058
(CANADA)	19,570	4.62	904
(DENMARK)	28,110	4.80	1,349
(FRANCE)	23,470	3.61	847
(GERMANY)	25,580	2.43	622
HUNGARY	3,840	4.31	166
(ICELAND)	24,590	4.77	1,173
(NETHERLANDS)	21,970	3.30	725
NEW ZEALAND	13,190	3.15	415
(NORWAY)	26,480	5.26	1,393
(SLOVENIA)	7,140	4.20	300
SWEDEN	23,630	4.92	1,163
SWITZERLAND	37,180	3.72	1,383
AVERAGE	21,263	4.07	869
PERFORMED SAME AS THE U.S.			
CZECH REPUBLIC	3,210	3.75	120
(ITALY)	19,270	2.89	557
(LITHUANIA)	1,350	2.18	29
(RUSSIAN FEDERATION)	2,650	—	—
PERFORMED BELOW THE U.S.			
(CYPRUS)	10,380	3.60	374
(SOUTH AFRICA)	3,010	5.12	154
AVERAGE (SAME AND BELOW)	6,645	3.51	247
(UNITED STATES)	**25,860**	**4.02**	**1,040**
INTERNATIONAL AVERAGE	17,305	3.93	722

— Data not available

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

GNP per capita and public expenditure figures based on estimates for 1994 at current market prices in U.S. dollars, except in Cyprus where GNP per capita figure is for 1993.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 5 and Figure 2.1. Chestnut Hill, MA: Boston College.

TABLE A5.17

AVERAGE AGE OF PARTICIPANTS IN TIMSS EIGHTH-GRADE MATHEMATICS ASSESSMENT AND FINAL YEAR OF SECONDARY SCHOOL MATHEMATICS GENERAL KNOWLEDGE ASSESSMENT AND NATIONS' RELATIVE STANDING IN ACHIEVEMENT IN THE TWO ASSESSMENTS

NATION'S STANDING RELATIVE TO THE INTERNATIONAL AVERAGE IN EIGHTH GRADE COMPARED TO FINAL YEAR OF SECONDARY SCHOOL	NATION	AVERAGE AGE OF PARTICIPANTS IN ASSESSMENT		DIFFERENCE IN AVERAGE AGE OF PARTICIPANTS IN THE TWO ASSESSMENTS[1]
		EIGHTH GRADE	FINAL YEAR OF SECONDARY SCHOOL	
HIGHER IN FINAL YEAR OF SECONDARY SCHOOL	(DENMARK)	13.9[2]	19.1	5.2
	(ICELAND)	13.6	21.2	7.6
	NEW ZEALAND	14.0[3]	17.6	3.6
	(NORWAY)	13.9[2]	19.5	5.6
	SWEDEN	13.9[2]	18.9	5.0
AVERAGE		13.9	19.3	5.4
SAME IN BOTH	(AUSTRIA)	14.3	19.1	5.8
	(CANADA)	14.1	18.6	4.5
	(CYPRUS)	13.7	17.7	4.0
	(FRANCE)	14.3	18.8	4.5
	(GERMANY)	14.8	19.5	4.7
	(LITHUANIA)	14.3	18.1	3.8
	(NETHERLANDS)	14.3	18.5	4.2
	(SOUTH AFRICA)	15.4	20.1	4.7
	SWITZERLAND	14.2[4]	19.8	5.6
AVERAGE		14.4	18.9	4.6
LOWER IN FINAL YEAR OF SECONDARY SCHOOL	(AUSTRALIA)	14.2[3]	17.7	3.5
	CZECH REPUBLIC	14.4	17.8	3.4
	HUNGARY	14.3	17.5	3.2
	(RUSSIAN FEDERATION)	14.0[4]	16.9	2.9
	(SLOVENIA)	14.8	18.8	4.0
	(UNITED STATES)	**14.2**	**18.1**	**3.9**
AVERAGE		14.3	17.8	3.5
INTERNATIONAL AVERAGE		14.2	18.7	4.4

1. Difference in average ages is calculated by subtracting the average age of the participants in the eighth grade mathematics assessment from the average age of the participants in the final year of secondary school mathematics general knowledge assessment.
2. Based on average age of participants in the seventh grade.
3. Based on average age of participants in eighth or ninth grade, depending upon the system in place in each state/territory (Australia) or age beginning primary school (New Zealand).
4. Based on average age in seventh or eighth grade, depending upon the system in place in each canton (Switzerland) or age beginning secondary school (Russian Federation).

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of national figures.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 1.1 and Figure 2.3. Chestnut Hill, MA: Boston College. Mullis et al. (1996). *Mathematics Achievement in the Middle School Years.* Table 1.1. Chestnut Hill, MA: Boston College.

TABLE A5.18

MATHEMATICS AND SCIENCE COURSETAKING AND CHANGE IN STANDING RELATIVE TO THE INTERNATIONAL AVERAGE BETWEEN EIGHTH GRADE AND FINAL YEAR OF SECONDARY SCHOOL

COMPARISON TO THE UNITED STATES ON COURSETAKING	PERCENTAGE OF STUDENTS CURRENTLY TAKING MATHEMATICS	PERCENTAGE OF STUDENTS CURRENTLY TAKING SCIENCE
NATION ABOVE U.S.	*(AUSTRALIA)* (CYPRUS) *CZECH REPUBLIC* **(DENMARK)** (FRANCE) *HUNGARY* (LITHUANIA) *(RUSSIAN FEDERATION)* *(SLOVENIA)*	*(AUSTRALIA)* (AUSTRIA) (CYPRUS) **(FRANCE)** *HUNGARY* **(ICELAND)** (LITHUANIA) **NEW ZEALAND** *(RUSSIAN FEDERATION)* *(SLOVENIA)* (SOUTH AFRICA)
NATION SAME AS U.S.	(AUSTRIA) **(ICELAND)** (NETHERLANDS) **NEW ZEALAND** **(NORWAY)** (SOUTH AFRICA) **SWEDEN** SWITZERLAND	(CANADA) (NETHERLANDS) **SWITZERLAND**
NATION BELOW U.S.	(CANADA)	*CZECH REPUBLIC* **(DENMARK)** (NORWAY) SWEDEN
DATA NOT AVAILABLE	(GERMANY)	*(GERMANY)*
(UNITED STATES)	**66%***	**53%***
INTERNATIONAL AVERAGE	79%	67%

* U.S. average is significantly different from the international average.

NOTES:

Nations not meeting international sampling and other guidelines for the end of secondary assessment are shown in parentheses. See Appendix I for details for each country.

Bold: Nations that have a higher relative standing compared to the international average in eighth grade than at the end of secondary school in that subject.

Regular: Nations in which the relative standing compared to the international average is similar in eighth grade and at the end of secondary school in that subject.

Italic: Nations that have a lower relative standing compared to the international average in eighth grade than at the end of secondary school in that subject.

International average is the average of the national figures.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Tables 4.2, 4.4, and Figures 2.3 and 2.4. Chestnut Hill, MA: Boston College.

TABLE A5.19

AVERAGE AGE OF PARTICIPANTS IN TIMSS EIGHTH-GRADE SCIENCE ASSESSMENT AND FINAL YEAR OF SECONDARY SCHOOL SCIENCE GENERAL KNOWLEDGE ASSESSMENT AND CHANGE IN NATION'S STANDING RELATIVE TO THE INTERNATIONAL AVERAGE FROM EIGHTH GRADE TO FINAL YEAR OF SECONDARY SCHOOL

CHANGE IN NATION'S STANDING RELATIVE TO THE INTERNATIONAL AVERAGE FROM EIGHTH GRADE TO FINAL YEAR OF SECONDARY SCHOOL	NATION	AVERAGE AGE OF PARTICIPANTS IN ASSESSMENT		DIFFERENCE IN AVERAGE AGE OF PARTICIPANTS IN THE TWO ASSESSMENTS[1]
		EIGHTH GRADE	FINAL YEAR OF SECONDARY SCHOOL	
HIGHER IN FINAL YEAR OF SECONDARY SCHOOL	(DENMARK)	13.9[2]	19.1	5.2
	(FRANCE)	14.3	18.8	4.5
	(ICELAND)	13.6	21.2	7.6
	NEW ZEALAND	14.0[3]	17.6	3.6
	SWITZERLAND	14.2[4]	19.8	5.6
AVERAGE		**14.0**	**19.3**	**5.3**
SAME IN BOTH	(AUSTRIA)	14.3	19.1	4.8
	(CANADA)	14.1	18.6	4.5
	(CYPRUS)	17.7	17.1	4.0
	(LITHUANIA)	14.3	18.1	3.8
	(NETHERLANDS)	14.3	18.5	4.5
	(NORWAY)	13.9[2]	19.5	5.6
	(SOUTH AFRICA)	15.4	20.1	4.7
	SWEDEN	13.9[2]	18.9	5.0
AVERAGE		**14.2**	**18.8**	**4.6**
LOWER IN FINAL YEAR OF SECONDARY SCHOOL	(AUSTRALIA)	14.2[3]	17.7	3.5
	CZECH REPUBLIC	14.4	17.8	3.4
	(GERMANY)	14.8	19.5	4.7
	HUNGARY	14.3	17.5	3.2
	(RUSSIAN FEDERATION)	14.0[4]	16.9	2.9
	(SLOVENIA)	14.8	18.8	4.0
	(UNITED STATES)	**14.2**	**18.1**	**3.9**
AVERAGE		**14.4**	**18.0**	**3.7**
INTERNATIONAL AVERAGE		**14.2**	**18.7**	**4.4**

1. Difference in average ages is calculated by subtracting the average age of the participants in the eighth grade mathematics assessment from the average age of the participants in the final year of secondary school mathematics general knowledge assessment.
2. Based on average age of participants in the seventh grade.
3. Based on average age of participants in eighth or ninth grade, depending upon the system in place in each state/territory (Australia) or age beginning primary school (New Zealand).
4. Based on average age in seventh or eighth grade, depending upon the system in place in each canton (Switzerland) or age beginning secondary school (Russian Federation).

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of national figures.

SOURCES: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Table 1.1 and Figure 2.4. Chestnut Hill, MA: Boston College. Mullis et al. (1996). *Science Achievement in the Middle School Years.* Table 1.1. Chestnut Hill, MA: Boston College.

TABLE A5.20
RESPONSES TO SELECTED STUDENT QUESTIONNAIRE ITEMS: RESPONSES OF STUDENTS PARTICIPATING IN MATHEMATICS AND SCIENCE GENERAL KNOWLEDGE ASSESSMENTS

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE OF STUDENTS CURRENTLY TAKING MATHEMATICS	PERCENTAGE OF STUDENTS CURRENTLY TAKING SCIENCE	AVERAGE HOURS OF HOMEWORK PER DAY	PERCENTAGE WHO USE A CALCULATOR "DAILY"
NATION ABOVE U.S. ON THIS FACTOR	(AUSTRALIA) *(CYPRUS)* CZECH REPUBLIC (DENMARK) ***(FRANCE)*** ***HUNGARY*** (ITALY) (LITHUANIA) (RUSSIAN FEDERATION) (SLOVENIA)	(AUSTRALIA) (AUSTRIA) *(CYPRUS)* (FRANCE)* HUNGARY* (ICELAND) (ITALY) (LITHUANIA) NEW ZEALAND (RUSSIAN FEDERATION) (SLOVENIA) *(SOUTH AFRICA)*	(AUSTRALIA) (AUSTRIA) (CANADA) *(CYPRUS)* (DENMARK) ***(FRANCE)*** ***HUNGARY*** (ICELAND) (ITALY) (LITHUANIA) NEW ZEALAND (RUSSIAN FEDERATION) (SLOVENIA) *(SOUTH AFRICA)* SWITZERLAND	(AUSTRALIA) (CANADA) *(CYPRUS)* (DENMARK) ***(FRANCE)*** ***HUNGARY*** (ICELAND) (NETHERLANDS) NEW ZEALAND *(SOUTH AFRICA)*
NATION SAME AS U.S. ON THIS FACTOR	(AUSTRIA) (ICELAND) (NETHERLANDS) NEW ZEALAND (NORWAY) *(SOUTH AFRICA)* SWEDEN SWITZERLAND	(CANADA) (NETHERLANDS) SWITZERLAND	(NETHERLANDS) (NORWAY) SWEDEN	(AUSTRIA) (ITALY) (LITHUANIA) (NORWAY) (SLOVENIA) SWITZERLAND
NATION BELOW U.S. ON THIS FACTOR	(CANADA)	CZECH REPUBLIC (DENMARK) (NORWAY) SWEDEN	CZECH REPUBLIC	CZECH REPUBLIC (RUSSIAN FEDERATION) SWEDEN
DATA NOT AVAILABLE	***(GERMANY)***	(GERMANY)*	***(GERMANY)***	***(GERMANY)***
(UNITED STATES)	66%★	53%★	1.7 HOURS★	52%
INTERNATIONAL AVERAGE	79%	67%	2.6 HOURS	55%

Notes for this table can be found at the end of table.

How to read this table: Columns represent responses to particular questionnaire items. The first three rows show how each nation's students responded in comparison with U.S. students on that item. The style of the font for the country names indicates how students in that country performed on the general knowledge assessment relative to the U.S. For example, the first column represents student responses to whether they were currently taking mathematics. The first row in the first column lists the 10 countries in which a higher percentage of students than in the U.S. reported that they were currently taking mathematics. The second row in the first column lists the 8 nations in which a similar percentage of students as the U.S. reported that they were currently taking mathematics. The third row in the first column lists the one nation in which a lower percentage of students than in the U.S. reported that they were currently taking mathematics.

TABLE A5.20—(CONTINUED)

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO USED A CALCULATOR ON THE TIMSS MATHEMATICS GENERAL KNOWLEDGE ASSESSMENT	PERCENTAGE WHO USE A COMPUTER AT SCHOOL, HOME, OR ELSEWHERE	PERCENTAGE WHO LIKE MATHEMATICS "A LOT"	PERCENTAGE WHO "LIKE" CHEMISTRY OR LIKE IT "A LOT"
NATION ABOVE U.S. ON THIS FACTOR	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** CZECH REPUBLIC **(DENMARK)** ***(FRANCE)*** ***(GERMANY)*** ***HUNGARY*** **(NETHERLANDS)** **NEW ZEALAND** **SWEDEN** **SWITZERLAND**	**(DENMARK)** **(ICELAND)**	**(DENMARK)** *(SOUTH AFRICA)*	**(ICELAND)** *(SOUTH AFRICA)*
NATION SAME AS U.S. ON THIS FACTOR	*(CYPRUS)* **(ICELAND)** (ITALY) **(NORWAY)** **(SLOVENIA)**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** **(NETHERLANDS)** **NEW ZEALAND** **SWEDEN**	*(CYPRUS)* **(ICELAND)** (ITALY) **SWITZERLAND**	**(CANADA)** *(CYPRUS)* (FRANCE)* (ITALY) **(NORWAY)** (RUSSIAN FEDERATION) **SWEDEN** **SWITZERLAND**
NATION BELOW U.S. ON THIS FACTOR	(LITHUANIA) (RUSSIAN FEDERATION) *(SOUTH AFRICA)*	*(CYPRUS)* CZECH REPUBLIC ***(FRANCE)*** ***HUNGARY*** (ITALY) (LITHUANIA) **(NORWAY)** (RUSSIAN FEDERATION) **(SLOVENIA)** *(SOUTH AFRICA)* **SWITZERLAND**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** CZECH REPUBLIC ***(FRANCE)*** ***HUNGARY*** (LITHUANIA) **NEW ZEALAND** **(NORWAY)** (RUSSIAN FEDERATION) **(SLOVENIA)** **SWEDEN**	**(AUSTRALIA)** **(AUSTRIA)** CZECH REPUBLIC **(DENMARK)** HUNGARY* (LITHUANIA) **NEW ZEALAND** **(SLOVENIA)**
DATA NOT AVAILABLE		***(GERMANY)***	***(GERMANY)*** **(NETHERLANDS)**	(GERMANY)* **(NETHERLANDS)**
(UNITED STATES)	71%★	73%★	21%★	49%★
INTERNATIONAL AVERAGE	79%	57%	15%	42%

TABLE A5.20—(CONTINUED)

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO "LIKE" EARTH SCIENCE OR LIKE IT "A LOT"	PERCENTAGE WHO "LIKE" PHYSICS OR LIKE IT "A LOT"	PERCENTAGE WHO "LIKE" BIOLOGY OR LIKE IT "A LOT"	PERCENTAGE WHO HAD SOMETHING STOLEN AT SCHOOL IN THE MONTH PRIOR TO TIMSS
NATION ABOVE U.S. ON THIS FACTOR	(LITHUANIA)	*(SOUTH AFRICA)*	**(ICELAND)** *(RUSSIAN FEDERATION)* *(SOUTH AFRICA)*	*(SOUTH AFRICA)*
NATION SAME AS U.S. ON THIS FACTOR	**(AUSTRIA)** **(CANADA)** CZECH REPUBLIC **(ICELAND)** (ITALY) *(RUSSIAN FEDERATION)* **(SLOVENIA)** *(SOUTH AFRICA)* **SWEDEN** **SWITZERLAND**	**(CANADA)** *(CYPRUS)* **(DENMARK)** (FRANCE)* **(ICELAND)** (ITALY) **(NORWAY)** *(RUSSIAN FEDERATION)* **SWEDEN** **SWITZERLAND**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** *(CYPRUS)* **(DENMARK)** (FRANCE)* HUNGARY* (ITALY) (LITHUANIA) **NEW ZEALAND** **SWEDEN** **SWITZERLAND**	**NEW ZEALAND**
NATION BELOW U.S. ON THIS FACTOR	**(AUSTRALIA)** *(CYPRUS)* **(DENMARK)** (FRANCE)* HUNGARY* **NEW ZEALAND** **(NORWAY)**	**(AUSTRALIA)** **(AUSTRIA)** CZECH REPUBLIC HUNGARY* (LITHUANIA) **NEW ZEALAND** **(SLOVENIA)**	CZECH REPUBLIC **(NORWAY)** **(SLOVENIA)**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** *(CYPRUS)* CZECH REPUBLIC **(DENMARK)** ***HUNGARY*** **(ICELAND)** (ITALY) (LITHUANIA) **(NORWAY)** *(RUSSIAN FEDERATION)* **(SLOVENIA)** **SWEDEN** **SWITZERLAND**
DATA NOT AVAILABLE	(GERMANY)* **(NETHERLANDS)**	(GERMANY)* **(NETHERLANDS)**	(GERMANY)* **(NETHERLANDS)**	***(FRANCE)*** ***(GERMANY)*** **(NETHERLANDS)**
(UNITED STATES)	**68%★**	**47%★**	**67%**	**24%★**
INTERNATIONAL AVERAGE	63%	42%	67%	13%

TABLE A5.20—(CONTINUED)

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO WERE THREATENED AT SCHOOL IN THE MONTH PRIOR TO TIMSS	AVERAGE HOURS OF TV OR VIDEO WATCHING ON A NORMAL SCHOOL DAY	AVERAGE HOURS AT A PAID JOB ON A NORMAL SCHOOL DAY	PERCENTAGE WHO WORK ONE OR MORE HOURS AT A PAID JOB ON A NORMAL SCHOOL DAY
ABOVE U.S. ON THIS FACTOR	*(SOUTH AFRICA)*	CZECH REPUBLIC ***HUNGARY*** (LITHUANIA) **(NETHERLANDS)** **NEW ZEALAND** (RUSSIAN FEDERATION)	NONE	NONE
SAME AS U.S. ON THIS FACTOR	**(AUSTRALIA)** *(CYPRUS)* CZECH REPUBLIC **(DENMARK)** **NEW ZEALAND**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** *(CYPRUS)* **(DENMARK)** **(ICELAND)** **(NORWAY)** **SWEDEN**	NONE	NONE
BELOW U.S. ON THIS FACTOR	**(AUSTRIA)** **(CANADA)** **(ICELAND)** (ITALY) (LITHUANIA) **(NORWAY)** (RUSSIAN FEDERATION) **(SLOVENIA)** **SWEDEN** **SWITZERLAND**	***(FRANCE)*** (ITALY) **(SLOVENIA)** *(SOUTH AFRICA)* **SWITZERLAND**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** *(CYPRUS)* CZECH REPUBLIC **(DENMARK)** ***(FRANCE)*** **(ICELAND)** (ITALY) (LITHUANIA) **(NETHERLANDS)** **NEW ZEALAND** **(NORWAY)** (RUSSIAN FEDERATION) **(SLOVENIA)** *(SOUTH AFRICA)* **SWEDEN** **SWITZERLAND**	**(AUSTRALIA)** **(AUSTRIA)** **(CANADA)** *(CYPRUS)* CZECH REPUBLIC **(DENMARK)** ***(FRANCE)*** **(ICELAND)** (ITALY) (LITHUANIA) **(NETHERLANDS)** **NEW ZEALAND** **(NORWAY)** (RUSSIAN FEDERATION) **(SLOVENIA)** *(SOUTH AFRICA)* **SWEDEN** **SWITZERLAND**
DATA NOT AVAILABLE	***(FRANCE)*** ***(GERMANY)*** ***HUNGARY*** **(NETHERLANDS)**	***(GERMANY)***	***(GERMANY)*** ***HUNGARY***	***(GERMANY)*** ***HUNGARY***
(UNITED STATES)	**11%★**	**1.7 HOURS**	**3.1 HOURS★**	**61%★**
INTERNATIONAL AVERAGE	7%	1.7 HOURS	1.2 HOURS	28%

★ U.S. average is significantly different from the international average.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

International average is the average of the national figures.

Bold: Nations that performed above the U.S. in both mathematics and science general knowledge.
Bold italic: Nations that performed above the U.S. in mathematics general knowledge only.
Regular: Nations that performed similar to the U.S. in mathematics and science general knowledge.
Italic: Nations that performed below the U.S. in both mathematics and science general knowledge.
* Because this factor concerns science general knowledge, and because these nations performed similar to the U.S. in science, they are not bolded for this factor.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Chestnut Hill, MA: Boston College.

TABLE A5.21
RESPONSES TO SELECTED STUDENT QUESTIONNAIRE ITEMS:
RESPONSES OF STUDENTS PARTICIPATING IN ADVANCED MATHEMATICS ASSESSMENT

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO ARE ASSIGNED MATHEMATICS HOMEWORK 3 OR MORE TIMES PER WEEK[1]	PERCENTAGE WHO USE A CALCULATOR AT SCHOOL, HOME OR ANYWHERE ELSE "DAILY"	PERCENTAGE WHO USED A CALCULATOR ON THE TIMSS ADVANCED MATHEMATICS ASSESSMENT	PERCENTAGE WHO RECEIVE 5 HOURS OR MORE OF MATHEMATICS INSTRUCTION PER WEEK[1]
NATION ABOVE U.S. ON THIS FACTOR	(CYPRUS)	(AUSTRALIA) (DENMARK) SWEDEN	CANADA (DENMARK) SWEDEN SWITZERLAND	(AUSTRALIA) CANADA (CYPRUS) FRANCE GREECE (LITHUANIA) (RUSSIAN FEDERATION)
NATION SAME AS U.S. ON THIS FACTOR	(AUSTRALIA) CANADA GREECE (RUSSIAN FEDERATION)	CANADA (CYPRUS) FRANCE	(AUSTRALIA) (AUSTRIA) CZECH REPUBLIC FRANCE (GERMANY)	(AUSTRIA) SWITZERLAND
NATION BELOW U.S. ON THIS FACTOR	(AUSTRIA) CZECH REPUBLIC (DENMARK) (ITALY) (LITHUANIA) (SLOVENIA) SWEDEN SWITZERLAND	(AUSTRIA) CZECH REPUBLIC (GERMANY) GREECE (ITALY) (LITHUANIA) (RUSSIAN FEDERATION) (SLOVENIA) SWITZERLAND	(CYPRUS) GREECE (ITALY) (LITHUANIA) (RUSSIAN FEDERATION) (SLOVENIA)	CZECH REPUBLIC (DENMARK) (ITALY) (SLOVENIA) SWEDEN
DATA NOT AVAILABLE	FRANCE (GERMANY)			(GERMANY)
(UNITED STATES)	90%★	82%★	86%★	12%★
INTERNATIONAL AVERAGE	65%	70%	76%	39%

Notes for this table can be found at the end of table.

How to read this table: Columns represent responses to particular questionnaire items. The first three rows show how each nation's students responded in comparison with U.S. students on that item. The style of the font for the country names indicates how students in that country performed on the general knowledge assessment relative to the U.S. For example, the first column represents student responses to whether they were assigned mathematics homework 3 or more times per week. The first row in the first column lists the one country in which a higher percentage of students than in the U.S. reported that they were assigned mathematics homework 3 or more times a week. The second row in the first column lists the 4 nations in which a similar percentage of students as the U.S. reported that they were assigned mathematics homework 3 or more times a week. The third row in the first column lists the 8 nations in which a lower percentage of students than in the U.S. reported that they were assigned mathematics homework 3 or more times a week.

TABLE A5.21 – (CONTINUED)

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO ARE ASKED TO USE COMPUTERS TO SOLVE MATHEMATICS EXERCISES OR PROBLEMS IN AT LEAST SOME MATHEMATICS CLASSES[2]	PERCENTAGE WHO ARE ASKED TO DO AT LEAST ONE REASONING TASK IN "EVERY MATHEMATICS LESSON"[2]	PERCENTAGE WHO ARE ASKED TO APPLY MATHEMATICS TO EVERYDAY PROBLEMS IN THEIR MATHEMATICS LESSONS[2]
NATION ABOVE U.S. ON THIS FACTOR	**(CYPRUS)** (ITALY) **(SLOVENIA)**	**(CYPRUS)** **GREECE**	NONE
NATION SAME AS U.S. ON THIS FACTOR	**(AUSTRALIA)** **(DENMARK)** **GREECE**	**(AUSTRALIA)** CZECH REPUBLIC (ITALY) **SWEDEN**	**(AUSTRALIA)** **CANADA**
NATION BELOW U.S. ON THIS FACTOR	(AUSTRIA) **CANADA** CZECH REPUBLIC **FRANCE** (GERMANY) **(LITHUANIA)** **(RUSSIAN FEDERATION)** **SWEDEN** **SWITZERLAND**	(AUSTRIA) **CANADA** **(DENMARK)** **FRANCE** (GERMANY) **(LITHUANIA)** **(RUSSIAN FEDERATION)** **(SLOVENIA)** **SWITZERLAND**	(AUSTRIA) **(CYPRUS)** CZECH REPUBLIC **(DENMARK)** **FRANCE** (GERMANY) **GREECE** (ITALY) **(LITHUANIA)** **(RUSSIAN FEDERATION)** **(SLOVENIA)** **SWEDEN** **SWITZERLAND**
DATA NOT AVAILABLE			
(UNITED STATES)	**34%★**	**43%★**	**85%★**
INTERNATIONAL AVERAGE	28%	32%	68%

★ U.S. average is significantly different from the international average.

1. Percentage based only on those students who reported that they were currently taking mathematics.
2. Percentage is based on all students concerning the current or the most recent mathematics course taken.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix I for details for each country.

International average is the average of the national figures.

Bold: Nations that performed above the U.S. advanced mathematics students on the advanced mathematics assessment.

Regular: Nations that performed similar to the U.S. advanced mathematics students on the advanced mathematics assessment.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School*. Chestnut Hill, MA: Boston College.

TABLE A5.22
RESPONSES TO SELECTED STUDENT QUESTIONNAIRE ITEMS: RESPONSES OF STUDENTS PARTICIPATING IN PHYSICS ASSESSMENT

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO RECEIVE PHYSICS HOMEWORK 3 OR MORE TIMES PER WEEK*	PERCENTAGE WHO USE A CALCULATOR AT SCHOOL, HOME OR ANYWHERE ELSE "DAILY"	PERCENTAGE WHO USED A CALCULATOR ON THE TIMSS PHYSICS ASSESSMENT	PERCENTAGE WHO CURRENTLY RECEIVE 5 HOURS OR MORE OF PHYSICS INSTRUCTION PER WEEK*
NATION ABOVE U.S. ON THIS FACTOR	(CANADA) (CYPRUS) GREECE NORWAY (RUSSIAN FEDERATION)	(AUSTRALIA) (CANADA) (CYPRUS) (DENMARK) NORWAY SWEDEN	(AUSTRALIA) (CANADA) (DENMARK) NORWAY SWEDEN SWITZERLAND	(CANADA)
NATION SAME AS U.S. ON THIS FACTOR	(AUSTRALIA) (DENMARK)	FRANCE (GERMANY) (SLOVENIA) SWITZERLAND	(CYPRUS) CZECH REPUBLIC FRANCE (GERMANY) (SLOVENIA)	(AUSTRALIA) (LATVIA) (RUSSIAN FEDERATION)
NATION BELOW U.S. ON THIS FACTOR	(AUSTRIA) CZECH REPUBLIC (GERMANY) (LATVIA) (SLOVENIA) SWEDEN SWITZERLAND	(AUSTRIA) CZECH REPUBLIC GREECE (LATVIA) (RUSSIAN FEDERATION)	(AUSTRIA) GREECE (LATVIA) (RUSSIAN FEDERATION)	(CYPRUS) CZECH REPUBLIC (DENMARK) (GERMANY) GREECE NORWAY (SLOVENIA) SWEDEN SWITZERLAND
DATA NOT AVAILABLE	FRANCE			(AUSTRIA) FRANCE
(UNITED STATES)	51%★	79%★	81%	17%★
INTERNATIONAL AVERAGE	40%	73%	79%	8%

Notes for this table can be found at the end of table.

How to read this table: Columns represent responses to particular questionnaire items. The first three rows show how each nation's students responded in comparison with U.S. students on that item. The style of the font for the country names indicates how students in that country performed on the general knowledge assessment relative to the U.S. For example, the first column represents student responses to whether they were assigned physics homework 3 or more times per week. The first row in the first column lists the 5 countries in which a higher percentage of students than in the U.S. reported that they were assigned physics homework 3 or more times a week. The second row in the first column lists the 2 nations in which a similar percentage of students as the U.S. reported that they were assigned physics homework 3 or more times a week. The third row in the first column lists the 7 nations in which a lower percentage of students than in the U.S. reported that they were assigned physics homework 3 or more times a week.

TABLE A5.22–(CONTINUED)

COMPARISON TO THE U.S. ON THE FACTOR	PERCENTAGE WHO ARE ASKED TO USE COMPUTERS TO SOLVE PHYSICS EXERCISES OR PROBLEMS IN SOME LESSONS*	PERCENTAGE WHO ARE ASKED TO DO AT LEAST ONE REASONING TASK IN "EVERY PHYSICS LESSON"*	PERCENTAGE WHO ARE ASKED TO CONDUCT LABORATORY EXPERIMENTS DURING SOME PHYSICS LESSONS*
NATION ABOVE U.S. ON THIS FACTOR	(SLOVENIA)	(CYPRUS)	NONE
NATION SAME AS U.S. ON THIS FACTOR	(CANADA) (CYPRUS) (DENMARK) FRANCE GREECE	CZECH REPUBLIC FRANCE GREECE	(CYPRUS) (DENMARK) FRANCE NORWAY SWEDEN
NATION BELOW U.S. ON THIS FACTOR	(AUSTRALIA) (AUSTRIA) CZECH REPUBLIC (GERMANY) (LATVIA) NORWAY (RUSSIAN FEDERATION) SWEDEN SWITZERLAND	(AUSTRALIA) (AUSTRIA) (CANADA) (DENMARK) (GERMANY) (LATVIA) NORWAY (RUSSIAN FEDERATION) (SLOVENIA) SWEDEN SWITZERLAND	(AUSTRALIA) (AUSTRIA) (CANADA) CZECH REPUBLIC (GERMANY) GREECE (LATVIA) (RUSSIAN FEDERATION) (SLOVENIA) SWITZERLAND
DATA NOT AVAILABLE			
(UNITED STATES)	42%★	36%★	96%★
INTERNATIONAL AVERAGE	29%	23%	79%

★ U.S. average is significantly different from the international average.

* Percentage based only on those students who reported that they were currently taking physics.

NOTES:

Nations not meeting international sampling and other guidelines are shown in parentheses. See Appendix 1 for details for each country.

'International average is the average of national figures.

Bold: Nations that performed above the U.S. physics students on the physics assessment.

Regular: Nations that performed similar to the U.S. physics students on the physics assessment.

SOURCE: Mullis et al. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Chestnut Hill, MA: Boston College.

APPENDIX 6
ADVISORS TO THE U.S. TIMSS STUDY

William Schmidt—Chair
U.S. TIMSS National Research Coordinator
Michigan State University

Gordon Ambach
Council of Chief State School Officers

Deborah Ball
University of Michigan

Audrey Champagne
SUNY University at Albany

David Cohen
University of Michigan

John Dossey
Illinois State University

Emerson Elliott
National Council for Accreditation of Teacher Education

Sheldon Glashow
Harvard University

Larry Hedges
University of Chicago

Henry Heikkinen
University of Northern Colorado

Jeremy Kilpatrick
University of Georgia

Mary Lindquist
Columbus State University

Marcia Linn
University of California at Berkeley

Robert Linn
University of Colorado

Paul Sally
The University of Chicago

Richard Shavelson
Stanford University

Bruce Spencer
Northwestern University

Elizabeth Stage
University of California at Berkeley

James Taylor
Global M

Kenneth Travers
University of Illinois

Paul Williams
University of Wisconsin

APPENDIX 7
ADDITIONAL TIMSS REPORTS

Ordering information for each of the following publications is located at the end of this appendix.

Asterisks indicate that the publication is included in *Attaining Excellence: A TIMSS Resource Kit.*

HOW CAN EDUCATORS, PRACTITIONERS, POLICYMAKERS, AND CONCERNED CITIZENS REFLECT UPON THEIR OWN LOCAL PRACTICES IN LIGHT OF TIMSS FINDINGS?

Attaining Excellence: A TIMSS Resource Kit, **September 1997 -This comprehensive package includes four modules which contain the following items: reports on the TIMSS findings; videotapes of classroom teaching in the United States, Japan, and Germany; guides for discussion leaders; presentation overheads with talking points for speakers; checklists, leaflets, and flyers. Note that the Kit's twelve publications and two videos include several items that are available individually elsewhere on this list. Those publications are denoted by an asterisk in the margin. $94. GPO Stock #065-000-01013-5.**

To order, contact: Superintendent of Documents. Also may be downloaded from http://timss.enc.org.

WHERE CAN I FIND A GOOD SUMMARY OF TIMSS FINDINGS THAT PUTS U.S. EDUCATION IN COMPARATIVE PERSPECTIVE?

******Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, **June 1997 -This report summarizes the most important findings concerning U.S. achievement and schooling in the fourth grade. Paperback, 68 pp. $4.75. GPO Stock #065-000-01018-6.**

To order, contact: Superintendent of Documents. Also may be downloaded from: http://nces.ed.gov/timss.

******Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, **November 1996 - This report draws from the assessments, surveys, video, and case studies of TIMSS to summarize the most important findings concerning U.S. achievement and schooling in the eighth grade. Paperback, 80 pp. $9.50. GPO Stock #065-000-00959-5.**

To order, contact: Superintendent of Documents. Also may be downloaded from http://nces.ed.gov/timss.

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF FOURTH-GRADE STUDENTS?

Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS), **June 1997 - This report focuses on third- and fourth-grade mathematics achievement in 26 countries, including background information about students and teachers. Paperback, 184 pp. + 52 pp. Appendix. $20.00 (+ $5.00 shipping & handling, if international).**

To order, contact: TIMSS International Study Center. Also may be downloaded from: http://www.csteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS), **June 1997 - This report focuses on third- and fourth-grade science achievement in 26 countries, including background information about students and teachers. Paperback, 148 pp. + 52 pp. Appendix. $20.00 (+ $5.00 shipping & handling if international).**

To order, contact: TIMSS International Study Center. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF EIGHTH-GRADE STUDENTS?

***Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, November 1996 - This report focuses on seventh- and eighth-grade mathematics achievement in 41 countries, including background information about students and teachers. Paperback, 176 pp. + 60 pp. Appendix. $30 (+$5.00 shipping and handling if international). GPO Stock #065-000-01023-2.**

To order, contact: TIMSS International Study Center or Superintendent of Documents. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

***Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, November 1996 - This report focuses on seventh- and eighth-grade science achievement in 41 countries, including background information about students and teachers. Paperback, 168 pp. + 62 pp. Appendix. $30 (+$5.00 shipping and handling if international). GPO Stock #065-000-01023-2.**

To order, contact: TIMSS International Study Center or Superintendent of Documents. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF TWELFTH-GRADE STUDENTS?

Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study (TIMSS) **February 1998 - This report focuses on mathematics and science achievement in 24 countries at the end of secondary school, including background information about students and teachers. Paperback, 236 pp. + 105 pp. Appendix. $30 (+$5.00 shipping and handling if international).**

To order, contact: TIMSS International Study Center. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

WHERE CAN I OBTAIN THE COMPLETE TIMSS INTERNATIONAL DATABASE IN ORDER TO PERFORM SECONDARY ANALYSIS?

TIMSS International Database **- The database contains achievement scores in mathematics and science for those countries that participated in TIMSS at the third- and fourth grades (Population 1) and the seventh- and eighth grades (Population 2), and questionnaire results for students, teachers, and principals. The database can be used with**

either SAS or SPSS software. Accompanied by User Guidebook.

The TIMSS International Database is available on CD-ROM from the IEA Secretariat. It is provided in ASCII format and may also be downloaded from: http://www.csteep.bc.edu/timss1/database.html

The Population 3 Database and User Guide will be available June 1998.

WHERE CAN I COMPARE STUDENTS' PERFORMANCE ON A SERIES OF PRACTICAL TASKS IN BOTH MATHEMATICS AND SCIENCE?

Performance Assessment in IEA's Third International Mathematics and Science Study, 1997 - **The regular TIMSS assessments were supplemented by hands-on performance assessments which measured 4th- and 8th-grade students' content and procedural knowledge, as well as their ability to use that knowledge in reasoning and problem solving. Students in 21 countries participated, making it the largest international performance assessment yet conducted. This report includes findings from the 21 countries and descriptions of the performance tasks. Paperback, 128 pp. + 45 pp. Appendix.**

To order, contact: TIMSS International Study Center. Also may be downloaded from http://www.csteep.bc.edu/TIMSS1/PAreport.html.

HOW CAN I GET A FIRST-HAND GLIMPSE OF ACTUAL CLASSROOM LESSONS IN THE U.S., GERMANY, AND JAPAN?

***Eighth-Grade Mathematics Lessons: United States, Japan, and Germany* - An 80-minute VHS tape with abbreviated versions of six eighth-grade mathematics lessons: one algebra and one geometry lesson each from the United States, Japan, and Germany, GPO Stock #065-000-01025-9, $20.**

To order, contact: Superintendent of Documents.

CD-ROM Video Examples from the TIMSS Videotape Classroom Study: Eighth-Grade Mathematics in Germany, Japan, and the United States - Actual episodes in eighth-grade mathematics classes let viewers see an abbreviated geometry and algebra lesson in each of three countries: Germany, Japan, and the U.S.

To order, contact: Superintendent of Documents.

Minimum System Requirements:
IBM PC or 100% compatible, MS Windows® (Windows 95® recommended), Pentium® (16 MB of RAM, 256 color SVGA or better, 2x or higher CD-ROM drive, Sound Card.

HOW CAN I LEARN MORE ABOUT THE LIVES OF STUDENTS AND TEACHERS IN THE U.S., JAPAN, AND GERMANY?

Contemporary Research in the United States, Germany, and Japan on Five Education Issues: Structure of the Education System; Standards in Education; The Role of School in Adolescents' Lives;

Individual Differences Among Students' and Teachers' Lives. 802 pp. $50.

The Education System in Germany: Case Study Findings. 406 pp. $25.
The Education System in Japan: Case Study Findings. 412 pp. $25.

The Education System in the United States: Case Study Findings. 341 pp. $20.

To Sum It Up: Case Studies of Education in Germany, Japan, and the United States. 166 pp. $10. (Shipping and handling, $5)

To order, contact: University of Michigan.

WHERE CAN I FIND OUT WHAT TIMSS HAS LEARNED ABOUT CURRICULUM?

A Splintered Vision: An Investigation of U.S. Science and Mathematics Education, 1997 - **This book enunciates the argument that math and science curricula in U.S. schools suffer from a lack of focus. The authors contend that in their effort to canvas as many topics as possible, both teachers and textbook publishers fail to delve into the most important subjects with sufficient depth. 176 pp. Hardback ISBN: 0-7923-4440-5, $87; Paperback ISBN: 0-7923-4441-3, $49**

To order, contact: Kluwer Academic Publishers Group.

Many Visions, Many Aims: Volume 1, A Cross-National Exploration of Curricular Intentions in School Mathematics, 1997 - **An analysis of mathematics curriculum guides and textbooks in 50 countries. This report looks at the sequence and the topics covered from kindergarten through the end of secondary school, analyzed in a comparative framework. 286 pp. Hardback ISBN: 0-7923-4436-7, $120; Paperback ISBN: 0-7923-4437-5, $55 .**

To order, contact: Kluwer Academic Publishers Group.

Characterizing Pedagogical Flow: An Investigation of Mathematics and Science Teaching in Six Countries, 1996 - **Describes the results of the Study of Mathematics and Science Opportunity (SMSO) survey, which investigated curriculum content and instructional methods in France, Japan, Norway, Spain, Switzerland, and the United States, using case studies in each participating country. 229 pp. Hardback ISBN: 07923-42720, $110; Paperback ISBN: 07923-42739, $49**

To order, contact: Kluwer Academic Publishers Group.

TIMSS Monograph Series No. 3 Mathematics Textbooks: A Comparative Study of Grade 8 Texts, 1995 - **An examination of eight mathematics textbooks for 13-year-olds for their pedagogical and philosophical similarities and differences. Texts are from the United States, the Netherlands, the United Kingdom, Norway, Spain, France, Switzerland, and Japan. Paperback, 96 pp. ISBN: 1-895766-03-6. $16.95.**

To order, contact: Pacific Educational Press.

WHERE CAN I FIND OUT MORE ABOUT THE METHODOLOGY OF TIMSS?

Third International Mathematics and Science Study: Quality Assurance in Data Collection, 1996 - **A report on the quality assurance program which ensured the comparability of results across partici-**

pating countries. The program emphasized instrument translation and adaptation, sampling response rates, test administration and data collection, the reliability of the coding process, and the integrity of the database. Paperback, 93 pp. + 91 pp. Appendix.

To order, contact: TIMSS International Study Center. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

***Third International Mathematics and Science Study: Technical Report, Volume 1 Design and Development*, 1996 - This report describes the study, design, and the development of TIMSS up to, but not including, the operational stage of main data collection. Paperback, 149 pp. + 40 pp. Appendix.**

To order, contact: TIMSS International Study Center. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

***TIMSS Monograph Series No. 1, Curriculum Frameworks for Mathematics and Science*, 1993 - This monograph explains the study's foci and its key first step - the development of the curriculum frameworks that served as the guide for designing the study's achievement tests. The frameworks are included in the appendices. Paperback, 102 pp. ISBN: 0-88865-090-6. $16.95.**

To order, contact: Pacific Educational Press.

***TIMSS Monograph Series No. 2 Research Questions and Study Design, 1996* - This monograph presents the study's research objectives along with discussions that include: the impact of prior studies on the design of TIMSS; how the research questions were derived from TIMSS' conceptual framework; and how the research questions and test items were tailored to meet the contexts of the participating countries. Paperback, 112 pp. ISBN: 1-895766-02-8. $17.95.**

To order, contact: Pacific Educational Press.

WHERE CAN I READ THE ACTUAL TEST ITEMS GIVEN TO STUDENTS?

***TIMSS Mathematics Items Released Set for Population 1 (Third and Fourth Grades)* - All publicly released items used to assess third- and fourth-grade students in the TIMSS study. Paperback, 98 pp. $20.00 (+ $5.00 shipping & handling, if international).**

***TIMSS Science Items Released Set for Population 1 (Third and Fourth Grades)* - All publicly released items used to assess third- and fourth-grade students in the TIMSS study. Paperback, 84 pp. $20.00 (+ $5.00 shipping & handling, if international).**

***TIMSS Mathematics Items Released Set for Population 2 (Seventh and Eighth Grades)* - All publicly released items used to assess seventh- and eighth-grade students in the TIMSS study. Paperback, 142 pp. $20.00 (+ $5.00 shipping & handling, if international).**

***TIMSS Science Items Released Set for Population 2 (Seventh and Eighth Grades)* - All publicly released items used to assess seventh- and eighth-grade students in the TIMSS study. Paperback, 127 pp. $20.00 (+ $5.00 shipping & handling, if international).**

***TIMSS Mathematics and Science Items Released Set for Population 3 (End of Secondary School)* - All publicly released items used to assess students in their**

final year of schooling in the TIMSS study. Paperback.

To order, contact: TIMSS International Study Center. Also may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

HOW CAN I FIND OUT MORE ABOUT EDUCATION IN VARIOUS TIMSS COUNTRIES?

***National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*, 1997 - Each participating country's education system is discussed in a separate chapter, considering geographic and economic influences, school governance, teacher education, and curriculum. Hardback, 423 pp. $75.**

To order, contact: Pacific Educational Press.

CONTACT INFORMATION:

Superintendent of Documents
P.O. Box 371954
Pittsburgh, PA 15250-7954
Telephone: (202) 512-1800
Fax: (202) 512-2250.

TIMSS International Study Center
Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP) Campion Hall Room 323
School of Education, Boston College
Chestnut Hill, MA 02167;
Telephone: (617) 552-4521;
Fax: (617) 552-8419;
Email: timss@bc.edu;
Internet: http://wwwcsteep.bc.edu.

The IEA Secretariat
Herengracht 487
1017 BT Amsterdam
The Netherlands;
Telephone: +31 20 625 36 25;
Fax: +31 20 420 71 36;
E-mail: Department@IEA.nl.

Kluwer Academic Publishers Group
Order Department
P.O. Box 358, Accord Station
Hingham, MA 02018-0358;
Telephone: (617) 871-6600;
Fax (617) 871-6528;
Email: kluwer@wkap.com;
Internet: http://www.wkap.nl or
http://ustimss.msu.edu/publicat.htm.

Pacific Educational Press
Faculty of Education
University of British Columbia
Vancouver, Canada V6T 1Z4;
Telephone: (604) 822-5385;
Fax: (604) 822-6603;
Email: cedwards@interchange.ubc.ca.

University of Michigan
Attn: Suyin Liang
Center for Human Growth and Development
300 N. Ingalls, 10th Floor
Ann Arbor, MI 48109-0406
Telephone: (734) 764-2443
(Please make checks payable to "The University of Michigan.")

145